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THE ROMANCE OF DOMESTICATED PLANTS[1]

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Man's fate is closely correlated with events of the distant past—events which occurred even before he existed. One such incident occurred about 225 million years ago, which was new among plants and eventually greatly changed the vegetative landscape. This accident resulted in the formation of a plant organ which we recognize as a seed. Heritable changes were not common in these more primitive seed-plants, but finally during the Cretaceous period (about 120 million years ago), the Angiosperms made their appearance. All of our common seed-bearing plants belong to this group, excepting the conifers. This new kind of propagule was unique in that it contained an embryo plant which resulted from a sexual union. Free water was not necessary in the fertilization process. Food accumulated in the embryo and in surrounding tissues of the seed, which could be used in further growth of the embryo and in germination. This new plant organ could withstand desiccation yet remain viable for months to hundreds of years. In many instances, it could survive low temperatures which ordinarily would kill vegetative parts of the same plant. The nature of this organ was such that it could, at maturity, become widely deciminated within its habitat and to other habitats by several natural agencies.

By means of this new kind of propagule a very successful land flora became established even over relatively arid regions, on all the continents except the antarctic. All land habitats were more fully occupied by plants than before. The total vegetation mass was greatly increased, which in turn changed the characteristics of soils. The stream of heritable variations which occurred in seed plants is almost beyond comprehension. These mainly occurred before there were any humans in existence. The beginnings of some understanding of such matters is but a century old. Taxonomists now recognize about 10,000 genera and at least 200,000 species of seed plants. Many more will undoubtedly be discovered as time goes on.

SOME HERITABLE VARIATIONS IN SEEDS

Perhaps it is trite to point out that probably in every species of seed plant certain heritable potentialities may become expressed only in the seeds. Such were some of the characters in garden peas (*Pisum sativm*) L. which Mendel studied in his classical work of nearly a century ago—smooth and wrinkled seed coats, and yellow and green. From these seed characters (fig. 1)[3] as well as variable

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characters from other parts of the pea plant, the fundamental principles of heredity applicable to both plants and animals, were discovered. Though lost for nearly forty years, these principles when rediscovered, sparked the new science of genetics with the beginning of the twentieth century. However, peas were not new to man in Mendel's time. They are among his oldest domesticated plants, the oldest recognizable remains dating 3000 B.C. from the Swiss lake dwellings of the Stone Age. The place of origin is in doubt, but may have been in the Mediterranean region or in Western Asia. The pea as we know it is a cultigen and botanists have been unable to locate it in the wild state.

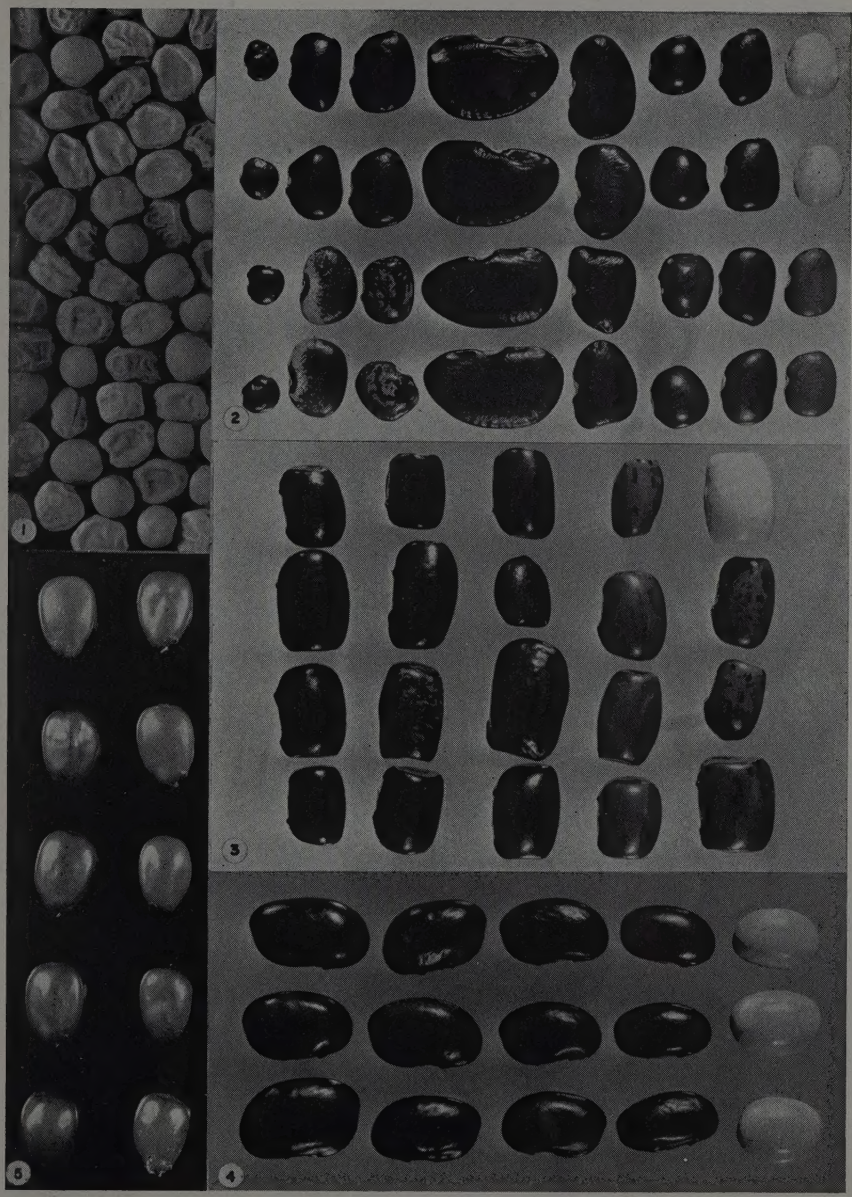
The kidney bean (figs. 3, 4) (*Phaseolus vulgaris*), probably originated in Brazil. However, its greatest diversity was reached in Guatamala and Mexico. The Peruvians were cultivating it about 4,500 years ago. It was widespread among North American Indians. More that 500 varieties have been given names in recent times. Much the same story may be told for the Lima Bean (*Phaseolus lunatus*) (fig. 2). This illustration shows something of the remarkable diversity of Lima Beans as to size, shapes and color patterns. These are from a collection of present-day varieties found in Guatamala and Mexico. These two species of beans are sources of basic food materials used by millions of people.

The Carob, Locust-bean, or St. John's Bread (*Ceratonia siliqua*) a leguminous tree of the Mediterranean region (fig. 5) has pods which are used for human consumption as well as feed for swine and cattle. The pods have been identified by some with the locusts of John the Baptist. The term "carat" has been applied to the Carob-bean or seed, and these seeds were used originally as a unit of weight, the Carat. When mature, the seeds seem to be fairly uniform in size, are very hard and the seed-coat is impervious to water until it is scarified. This matter of the seed-coat being impervious to water is a heritable characteristic and is found in the seed-coats of many species. It is of concern to horticulturists, agronomists, foresters and botanists. The water-proof coats of seeds and some fruits is obviously correlated with longevity of the embryo. The most prominent example is that of East Indian Lotus (*Nelumbo nucifera* Gaertn.) (fig. 7) These are botanically fruits with a single seed inside. The fruit coat (pericarp) is the structure which is impermeable to water. When the fruit coat is notched germination may occur within ten days. A quantity of these fruits were recently discovered in the depths of a peat bog in southern Manchuria. The seeds were viable and would germinate readily upon scarification of the pericarps. By the Radiocarbon technique these seeds were shown by Libby in 1951 to be about 1,000 years old. The seeds and rhizomes have been used as food by peoples of Asia for many centuries. The North American species, the water chinquapin (*Nelumbo lutea* Willd.) Pers., was used as a source of food by the Indians.

In any seed collection one of the most conspicuous to be found is the Castor-Bean (*Ricinus communis*) (fig. 6). This is not a legume but belongs to the spurge family. Though widely naturalized through the tropics, it probably originated in Africa with India as a second best choice. In the seed coats we find remarkable variations in colors and patterns, as well as size and shapes of the seeds. In addition, the endosperm synthesizes castor-oil which youngsters would readily proclaim as being different from any other, as a vile substance which should never have happened. In addition to its medicinal value, it is of importance industrially.

EXPLANATION OF FIGURES IN PLATE I

1. Garden Pea (*Pisum sativum*) seeds.
2. A collection of Lima Bean (*Phaseolus lunatus*) seeds from Guatemala, varying in size, shape, color and seed-coat patterns. Most of the dark colored areas are shades of red.
3–4. Common bean (*Phaseolus vulgaris*) seeds from Guatemala and Mexico. These and the Lima Beans of figure 2 are from a collection made by Mr. Webster McBride.
5. Seeds of St. John's Bread (*Ceratonia siliqua*).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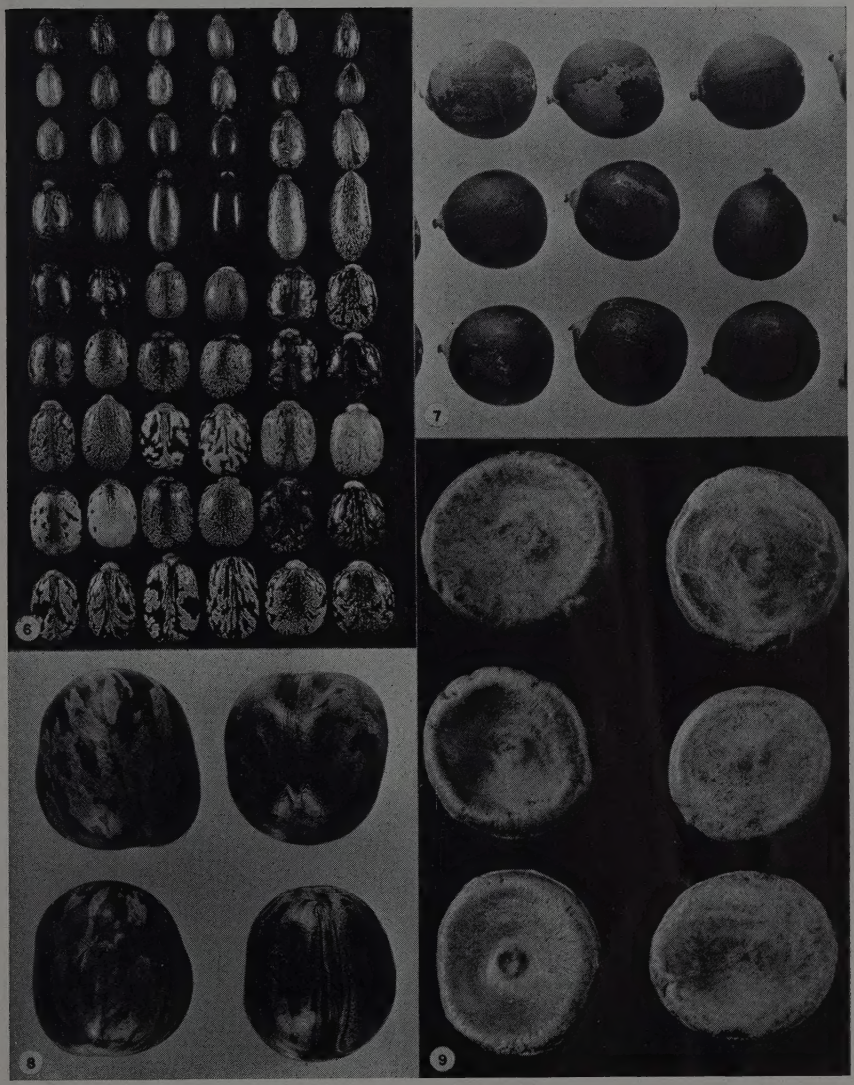
Another member of the spurge family is the Para Rubber tree (*Hevea brazilensis*) with a few of its unusual seeds (fig. 8) exhibiting characteristic patterns. It is a native of the Amazon. Although found in negligible amounts in the seeds, a latex with high rubber content is synthesized in the vegetative parts of the plant. This tree is the chief source of natural, commercial rubber. Although the natives are said to have learned to make rubber balls from the latex, a crude syringe, and was used for water-proofing some clothing, nothing was done about domestication until recent decades. I need not dwell upon the importance of rubber in modern economy, but only need to mention our experiences after the Pearl Harbor disaster.

Highly pigmented seeds are found distributed rather widely among plant families. The Sword Bean (*Canavalia gladiata*) (fig. 11) from tropics of the Old World. The large seeds are edible and they are used as ornaments. The Rosary Pea (*Abrus precatorius*) (fig. 10), another bean from tropics of Asia has a hard, scarlet coat with a black spot. They are used extensively in the tropics for beads, rosaries and other ornaments. The powdered seeds made into a paste and applied to arrows or darts make any wound fatal in about 24 hours. Seeds of the Strychnine Tree (*Strychnos nux-vomica* L.) (fig. 9), native of India and Indo-China, are disc-shaped and about an inch in diameter. These seeds yield the very poisonous substance known as Strychnine, and is of importance medicinally. Another species of *Strychnos*, native of South America yields curare, a deadly poison used by natives for poisoning arrows, and is now coming into importance in modern medicine.

The dye known as Annatto from the "Lipstick Plant", (*Bixa orellana*) (fig. 12) used in the coloring of oleomargarine is a tropical American Species. The dye is made in the outer soft, red layer seen in the illustration. This layer is an extra seed coat which is found in some species and is known as an aril. The spice known as Mace is from the aril of the nutmeg seed. When you eat the Chinese fruit called the Litchi, you eat only the fleshy aril. Another seed with an aril (fig. 13) is from the Bird-of-Paradise flower, (*Strelitzia nikolai*), a mat of tangled orange-colored hairs which grow at one end of the seed. And another (fig. 14) the seed of the Traveler's Tree (*Ravenala madagascariensis*) with the membranous, metallic-blue colored aril enfolding the seed. This metallic-blue pigment is unusual among plants. These two last species belong to the banana family. In either case the arils are of no use to the plants. Yet, these continue to develop on each new crop of seeds and from generation to generation.

Seeds may vary through out-growths from the seed-coat, forming wings, spines and hairs. Cotton seeds (fig. 17) is an extreme example with long hairs growing from the entire surface of the seed coat. These hairs of the cotton certainly have no survival value to the plant, in fact they are a disadvantage to distribution of the seeds in the wild state. There are many varieties of cotton (*Gossypium*) derived from indigenous species from both the Old and the New World. It is known that some Peruvians were cultivating cotton and were weaving textiles from it in 2500 B.C. Most of the cotton in cultivation in the United States is of American origin. These varieties have 52 chromosomes while the African and Asiatic varieties have 26 chromosomes and will not hybridize except on rare occasions. Because of this the Old and New World types have remained distinct even though they were brought together in our southern states in the earlier periods of cotton culture. Although the species of the two types will not readily cross, the hairs or fibers from the seed coats are very similar. It is remarkable that widely separated primitive peoples of the two hemispheres, independently learned to make textiles from the cotton fibers and domesticated the plants more or less simultaneously.

Variability in dimensions and weight of seeds may add to our appreciation of this plant organ. In various acid soil areas in Ohio, a native orchid, known as the Rattlesnake Plantain (*Goodyera pubesens* (Willd,) R. Br. may be found.



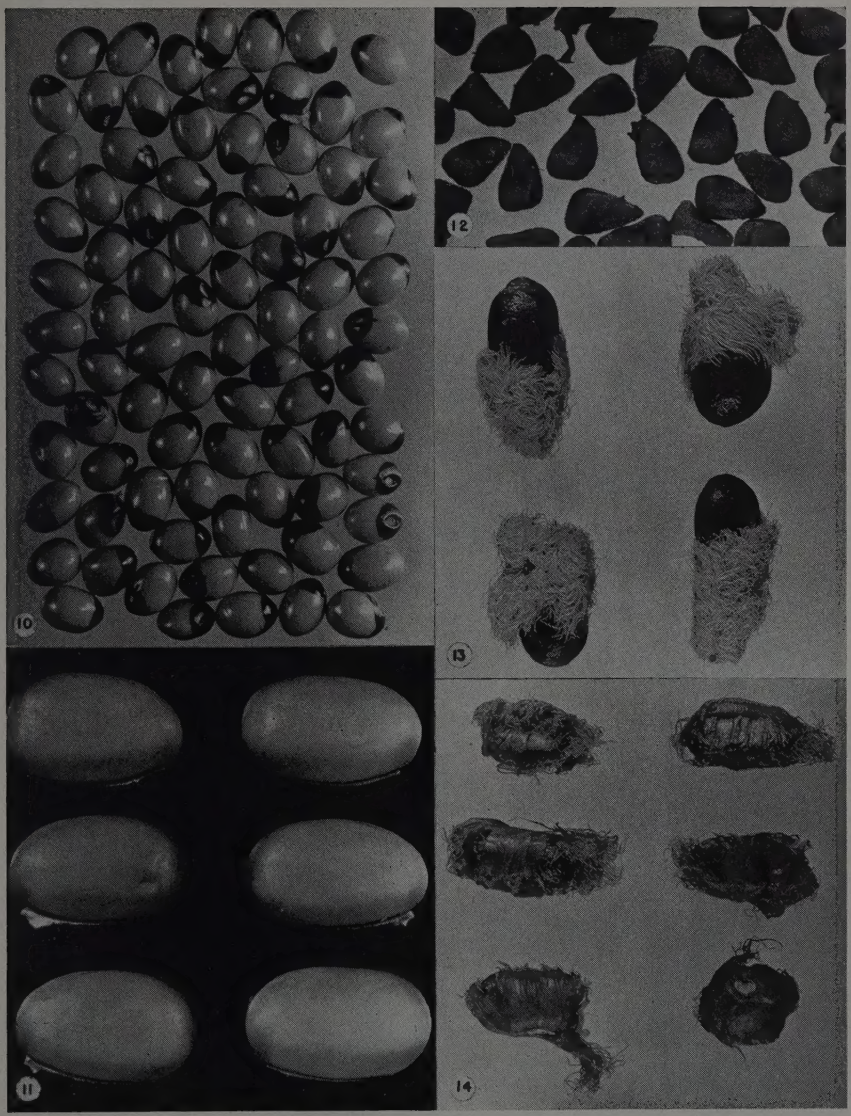
6. Castor-bean seeds.
7. Fruits of Lotus (*Nelumbo lutea*).
8. Seeds of Para Rubber Tree (*Hevea braziliensis*).
9. Seeds of Strychnine Tree (*Strychnos nux-vomica*).

The seeds (fig. 16) of this plant are among the smallest known. The dimensions of this magnified specimen is approximately 0.02 in. long by 0.003 in. wide (641.4X 95.3 microns). The weight is about .000002 g., or in other words, it takes 2 million of these seeds to weigh a gram. Many other orchids have seeds with dimensions and weight in about this category. In addition, one of the tropical orchids is known to bear about a million seeds to a flower or fruit.

The natives of the Seychelles islands in the Indian Ocean and Oriental lands bordering this body of water, are accustomed to find a somewhat monstrous object (fig. 15) washed upon the beaches. For centuries it was thought to be a product of the ocean and was called *coco de mer*, with many legends and superstitions developing about it. The hollowed-out shell was highly valued by potentates of the Orient as containers for drinking water. The shell was believed to contain an antidote to any poison which might have been added to the water. In the early part of the 19th century the fan palm (*Lodoicea sechallarium*) was discovered growing on Praslin island. The nut or stone and seed are ordinarily two-lobed, appearing as though two large coconuts had partially joined, and are now commonly called the Double Coconut. Occasionally a three-lobed stone is found, which has led to the fallacy that a single fruit may bear from two to three seeds. There is but one seed to a fruit, which is usually two-lobed, about 13 in. wide and 12 in. long with a weight of about 40 lb.—the largest seed known!

If we were asked to pick out the plant family which is of greatest importance to man and other mammals it undoubtedly would be the grasses (Graminaceae). There are over 5,000 species of grasses known, having a world wide distribution, from aquatic to desert habitats and from the tropics to the arctic. The grains of grasses are botanically fruits—a fruit with a single seed, which adheres to the membraneous fruit coat or pericarp. This illustration (fig. 18) is a microscopic, longitudinal section of a corn grain. The fruit coat is evident as a thin tissue surrounding the relatively large seed. The embryo is in the lower part of the grain, with the remaining large mass of tissue, the endosperm. This tissue is unique in that it develops ordinarily from the fusion of three nuclei, a male gamete and two nuclei of the embryo sac which are identical genetically to the egg or female gamete. Since these three nuclei are each haploid, the endosperm nucleus, which results form the three nuclei fusing, is triploid, or has the $3n$ number of chromosomes or 30 ordinarily in corn. Since all the cells of the endosperm tissue are decedents of the triple fusion nucleus, all the cells of the endosperm are triploid. While this is occuring, another male gamete fuses with the egg. The fertilized egg or zygote then is diploid or has the $2n$ number of chromosomes, which in corn ordinarily is 20. By cell division the zygote becomes an embryo, every cell of which is diploid, and as the growth including cell division continues, maturity of the plant is attained, with all the cells of the roots stem and leaves being descendents of the fertilized egg, each having the diploid number of chromosomes.

The corn endosperm (fig. 18 E) is noted for the great accumulation of foods, carbohydrates and protein. It is a basic food source for many people and it has no equal as feed for farm animals. Last year (1952) 3,306,000,000 bushels grew on the farms of the United States. Numerous genetic variations (fig. 21) occur in the endosperm, as to kind of carbohydrate, the physical qualities and pigmentation. In this illustration six fundamental endosperm types are shown on the ear—Floury, Dent Starchy, Flint, Sweet, Waxy and Pop. The Floury type of endosperm has a high percentage of starch in relation to the protein content, is soft and readily ground by the primitive methods of the Indians and was a common variety with them. Our common field corn varieties are of the Dent Starchy type. The Flint type of endosperm is hard and horn-like, and was cultivated extensively by the Indians. Sweet corn although known by the ancient Peruvians and by a few of the North American Indians in the latter part of the 18th century, it never became important with them, and white man became interested in it about a century



10. Rosary Pea (*Abrus precatorius*), scarlet with a black spot about the hilum.
11. Sword Bean (*Canavalia gladiata*) seeds of a purplish-red color and an inch or more in length.
12. Seeds of Annatto (*Bixa orellana*) with velvet-like coat of a maroon color. These with the *Abrus* of figure 10, were supplied by Capt. Wm. A. Fuller, Cocoa, Fla.
13. Seeds of Bird-of-Paradise Flower (*Strelitzia nikolai*) with a brilliant orange-colored aril.
14. Seeds of the Traveler's Tree (*Ravenala madagascariensis*), with the membranous, fringed, metallic blue aril enfolding them.

ago. Waxy corn is characterized by the presence of a waxy carbohydrate, erythrodextrin. Its culture history is uncertain. The Indians apparently made no use of it. Geneticists in this century found in it a useful tool in certain genetic studies and preserved stocks for that purpose. When World War II came along, cutting off the supply of Cassava—used in the manufacture of tapioca—a considerable acreage of hybrid waxy corn developed, with the erythrodextrin used in the making of tapioca and postage stamp glue. Popcorn seeds have a hard, horny endosperm which explodes when heated, forming the white, soft, spongy mass of this popular confection. It was known and used by the ancients of Mexico and Central America.

This illustration (fig. 22) shows the results of crossing a pure line red flint plant with a pure white flint corn plant. The ears borne on the white plant as a result of the cross pollination will be red grained and the embryo in every grain will be hybrid. When these hybrid grains are planted, and the mature, hybrid plants are self pollinated, the resulting ears will show a segregation of three red grains to one white, a typical, simple Mendelian ratio. If a pure white grained plant is pollinated with pollen from a hybrid individual, the ear developing on the white plant will show a 1:1 ratio of red to white grains,—and demonstrate the "back-cross" of the geneticists. Because of these heritable variations and many others, corn or maize has become one of the most important tools in the study of heredity.

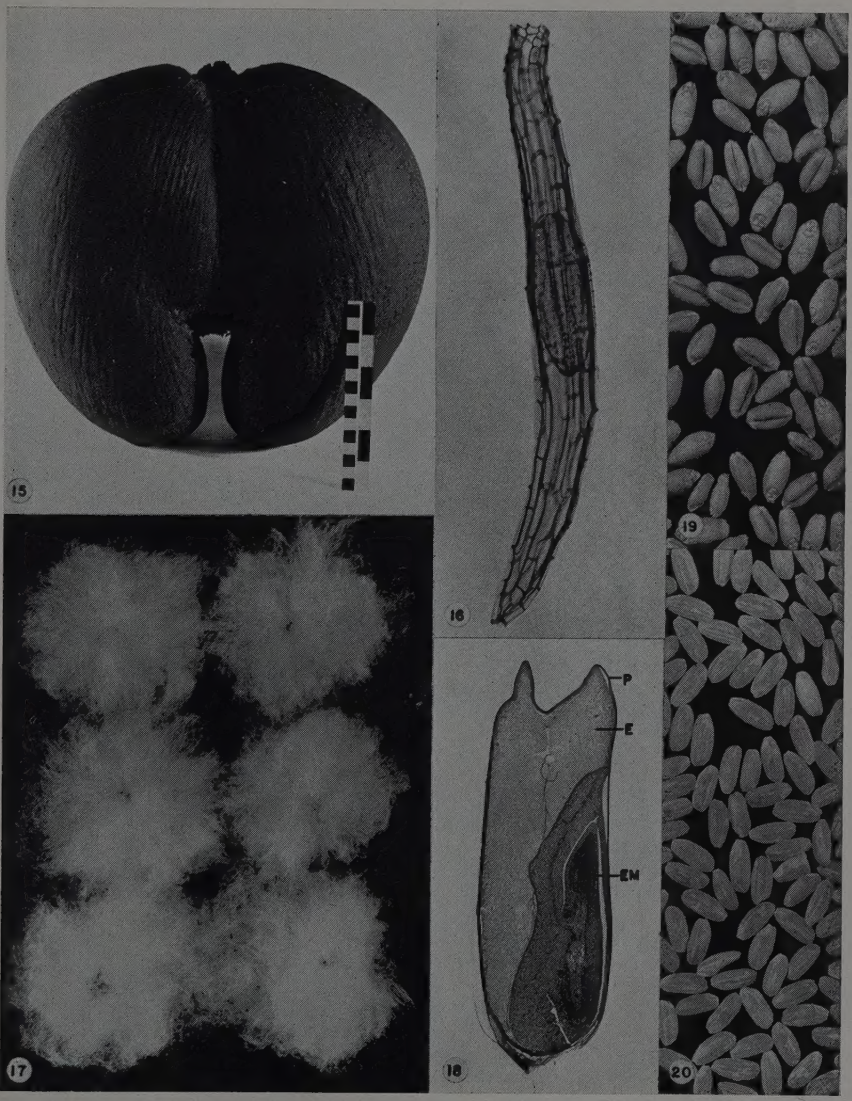
Wheat (*Triticum aestivum*) (fig. 19) is another grain of the grass family, which has been in cultivation for a least 5,500 years. The earliest remains were found in Mesopotamia. The grain is not as large as the maize grain, but has a large endosperm with starch and protein having accumulated in it. The wheat seed is a basic source of food, serving nearly half the human population of the world. In the United States the wheat yield was 1,291,000,000 bushels in 1952.

Some place in southeastern Asia, rice (*Oryza sativa*) (fig. 20) became domesticated earlier than 2,800 B.C. Over 5,000 varieties have been recorded. The wild ancestor is unknown. The rice seed is a basic source of food for nearly a billion people.

MAN AND HIS DEPENDENCE UPON SEED PLANTS

By the beginning of the great Ice Age, the Pleistocene Period, 1,500,000 years ago, the world stage of vegetation became set in such a way that our modern seed plants (angiosperms) were highly developed. A new actor began to make appearances on this stage—he was known as man. He was able to survive because of the right kind of food supply from the abundant flora, materials were available from which he could make clothing, construct shelter, use as fuel for warmth and solace for his ailments. He was a wanderer, endowed with intelligence far superior to any other animal, and had inherited knowledge of how to survive passed on to him by his primate ancestors. It was essential for him to have intimate knowledge of the plants which were useful to him as well as those which were harmful—developing the rudiments of plant taxonomy. He learned to make weapons in protecting himself from other animals, and eventually to use these animals for food and their skins for clothing. Some groups learned to live almost entirely by hunting, making it necessary to follow the herds. Some remained as gatherers of food, or perhaps some combination of the two methods of livelihood. They learned to care for particular trees perhaps which bore desirable fruit. In the digging for edible roots, bulbs, tubers, and rhizomes, they became aware of vegetative propagation.

Some of the more botanically minded noticed that some of the seeds they ate had sprouts on them, and upon looking further saw various seedling stages through to mature plants bearing the same kind of seed. The discovery of these relatively simple processes and attendent relationships were no doubt slow and torturous—even as we find it today for some college students in general botany! Primitive



15. Double Coconut, the largest seed known.
16. A photomicrograph of Rattlesnake Plantain seed, among the smallest known. The oval body is an embryo within the seed-coat.
17. Cotton seeds.
18. Longitudinal section of a corn grain with the membranous pericarp (*P*), large endosperm (*E*) and the embryo (*Em*).
19. Wheat grains.
20. Rice grains.

man learned not only to collect and plant the seeds but to care for them in various ways. He learned how to store them for the interval between collecting and planting, how and where the planting should be done. He observed that when planted in some organic waste, that the plant grew better and bore more seeds and fruit. He became aware of differences in the various popagules and selected for planting those which appeared most desirable to him. These were the beginnings of horticulture and agriculture.

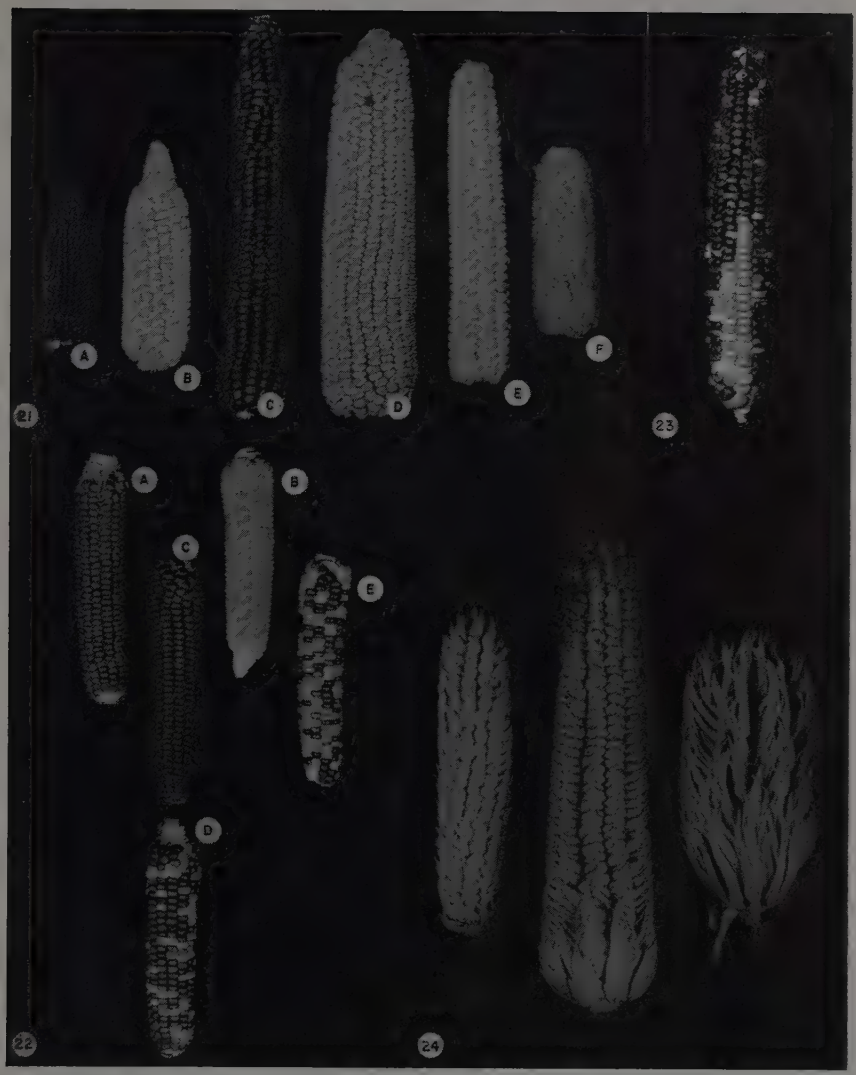
As the primitive hunters populated the continent of their origin, some groups migrated to other continents when opportunities arose. A land bridge once existed from Africa across Sicily to Italy, over which plants and animals, including early man probably migrated. Due to the vast accumulation of water in the form of glacial ice, sea levels were lowered to the extent that land connections were possible between Siberia and North America, in the area of Bering Strait. The bands of Asiatic hunters entered Alaska by this route, eventually populating both North and South America. The most direct route would cover more than 5,000 miles from Arctic through tropical climates, establishing a great number of primitive cultures, eventually leading to the establishment of the classic civilizations of the Incas, Myans, and Aztecs, within a period of about 15,000 years. Though fantastic, this is based on the best inferences of archeologists and geologists.

The movement of the Siberian primitives into North America must have been slow, perhaps taking many human generations. They came from a cold northern region which probably had no agricultural plants. There is no evidence for even a single species of domesticated seed-plant having arrived from Europe, Africa or Asia in pre-Columbian times. It is possible that man arrived in North America before there were any domesticated plants in Asia or elsewhere, and that domestication of plants in this hemisphere may have occurred more or less simultaneously with that in the Old World. As these people moved into the Americas they came in contact with a vast, new seed-plant flora with geneplasms very different from those experienced by their ancestors. The Indians are known to have made use of over a thousand species of native plants in what is now the United States. Out of these only the sunflower and Jerusalem Artichoke can be regarded as domesticated. However, many species were added to the list from Mexico, Central America and South America.

DOMESTICATED PLANTS NATIVE TO THE AMERICAS

A partial list of the more important plants domesticated in pre-Columbian times may help us visualize and appreciate the efforts of the first people of the New World. Maize or Corn with perhaps more than 8,000 varieties should head the list and is the only important cereal which originated in the Americas; The Potato in its many varieties, now a staple food source used by many millions of people; No vegetable counter is complete without Sweet Potatoes the year round, also a great source of commercial starch; Cassava, a staple food in the tropics, and a source of waxy carbohydrate used in the manufacture of Tapioca; fine pastries are made from the starch of Arrowroot and Canna; Lima beans in considerable variety; Kidney beans from which snap beans, soup beans, and field beans developed; millions of tons of Tomatoes are annually consumed in the United States today; Hot and Sweet Peppers widely used as condiments and to camouflage left-over ground meats; Tobacco, introduced into Europe about 450 years ago has become the "sovereign master of practically all mankind"; another narcotic—Coca, the plant which yields cocaine, with 15,000,000 South Americans as addicts; Coca or Chocolate; Annatto—a vegetable dye, now used extensively for the coloring of oleomargarine, butter and cheese; Peanut Squash, Pumpkin and the Chayote; and important fruits such as the Pineapple, Avocado, Papaya, Guava, Custard Apple and the Sapodilla.

It may be pertinent to point out here that all the *basic* food plants, upon which



21. Six endosperm types of corn, *A* Red Pop, *B* Waxy, *C* Red Flint, *D* Yellow Dent Starchy, *E* White Flour, *F* Sweet Corn.
22. Pure Red Flint (*A*) corn, White Flint (*B*), Hybrid (*C*), Ear from selfed hybrid (*D*) showing segregation; and (*E*) with a 1 : 1 ratio of red to white grains, resulting from a backcross of a hybrid (*C*) with the recessive white (*B*).
23. An ear of Variegated Maize with a block of white and yellow grains near the base, which are the result of a mutation having occurred.
24. Pod corn ear variation.

we are dependent, came into existence in pre-Columbian times. No new, basic food plant has developed from the wild species, in either hemisphere, since that time. The Concord, Catawaba and Delaware grapes derived from our native fox grape, the Cranberry derived from the wild species, long used by the Indians; the Modern Strawberry has resulted from hybridization of the North American species and a Chilean species. The above grapes, cranberry and strawberry developed during the 19th century, and in the present century the blueberry has been added. Important as they are, these can scarcely be regarded as basic food plants.

HOW DOMESTICATED PLANTS DIFFER FROM WILD SPECIES

Domesticated plants differ from wild species in that the domesticated species ordinarily cannot survive without human assistance. This service is characterized by planting (sowing or propagating), protecting, selecting and preserving. Most of the activities in horticulture and agriculture are concerned with how these practices may best be accomplished.

Heritable variation is the rule among seed plants rather than the exception. The frequency of these variations may be high for some species and low in others. The quality of the variation may range from something that is of great value in survival of the species growing in the wild, to characters which are neutral, through degrees of inhibiting influence to lethal variations. It should be kept in mind that such variations occur in an individual plant of a species, and never simultaneously in all individuals in the population of a given species. If one wishes to observe such variations, he must study individuals for these variations. The early horticulturalist had incentive to observe and tend individuals rather than large segments of a population in his small garden, since he was dependent on the small patch for food. Any variation discovered which met his needs better, were selected, protected, preserved and finally propagated. The variation was selected because it suited his purposes better and without regard to the survival value of the plant growing in the wild state. If good enough, from his standpoint, he would plant his whole plot to the variant and eliminate the less desirable ancestral type. Other members of his tribe planted it too, and eventually many groups in a large area were culturing the new and desirable variant. Additional variations occurred from time to time and were allowed to accumulate. Eventually the accumulated heritable differences were so great that the wild ancestor was no longer recognized, and the domesticated form was attributed to a Diety of this or that. This is true for a large number of domesticated plant species from both the eastern and western hemispheres. It was mentioned earlier for the garden pea. It appeared to be true for wheat, (until recently), rice, potato, tobacco and others, with maize or corn as the crowning example.

The wild ancestor of corn is unknown. It has either become extinct, or is so different in appearance that it has not yet been recognized. There is some evidence that pod corn was cultivated by the Cochise Indians of Arizona about 3,000 years ago (fig. 24), Pod corn differs from ordinary maize in that each grain on the ear is enclosed in a husk (bracts of the spikelet bearing the grain). The pod character is controlled by a single dominant gene. Some have regarded this as being the original wild corn. This notion has been questioned, since pod corn is no more able to survive in nature without the aid of man, than is ordinary corn. The pod-character is readily transmitted to any other variety of corn by cross pollination, resulting in a new combination or a recombination of characters. A similar case was mentioned earlier in which white flint corn was crossed with red flint. Any of the many varieties of corn will readily cross. This hybridization went on in gardens of primitive man and undoubtedly occurred more rapidly than in the wild state, because of the greater concentration of plants.

In some plants, with maize as the outstanding example, the hybrid (hetero-

zygous) individuals are more vigorous than either of the parents. Man was unaware of this hybrid vigor (heterosis) until Shull discovered it in 1908 and 1909. This discovery was not put into practice for almost 25 years. Now, about 90 percent of corn acreage is hybrid. As a result of using hybrid seed for planting as much as 25 percent increase in yield may result. This ranks as one of the greatest achievements in plant breeding.

Some place in the area from Mexico to Honduras, in pre-Columbian period, there is some evidence that maize crossed with *Tripsacum* (Gama-grass) and from the hybrid or its segregates Teosinte (*Euchlaena*) resulted. The crossing of these two genera is difficult, but it has been accomplished in a few instances by Mangelsdorf and Reeves, through a special technique. The chances for it to occur in nature are remote. However, Teosinte has a set of chromosomes which appear like those of corn and a set similar to *Tripsacum*. Taxonomists have given Teosinte the rank of a new genus (*Euchlaena*) since it is so different from either *Tripsacum* or Corn. If the above story is true, we have the unusual case of hybridization between two genera resulting in a third genus of grasses. The early Indians did not make much use of teosinte as a domesticated plant, but is used now to some extent as a forage plant.

FIGURE 25. The common Day-Lily (*Hemerocallis fulva*, clone *Europea*).

A CAUSE OF STERILITY IN SOME HYBRIDS

Hybridization between two rather distantly related individuals often results in the hybrid individuals being sterile. This sterility may be due to differences in the chromosomes from the male parent and the female. These differences may not prevent fertilization taking place when the male gamete comes in contact with the egg-cell. If this occurs in Day-Lily (*Hemerocallis fulva*) the sperm would have 11 chromosomes and the egg would have 11 chromosomes. The fertilized egg or zygote would have 22 chromosomes or the diploid number. There is no orderly arrangement of the 22 chromosomes within the zygote nucleus. The zygote divides mitotically resulting in two new cells which are identical, as far as the chromosomes are concerned, and each would be identical to the zygote from which they came. In the same way, since the leaves, stems and roots become initiated from the embryo by the same kind of cell divisions, it becomes evident that all cells of the vegetative plant are identical. This continues to be true for the flower parts up to and including the so-called mother-cells of the anthers and ovules. The mother cells are the immediate forerunners of the gametes. However, it is common knowledge that gametes (sperms and eggs) have the monoploid number of chromosomes or half the number found in any cell of a leaf stem or root. The reduction from

the diploid number to the monoploid occurs in the first two divisions of the mother cells in the anthers and ovules. The sperm of a Day-Lily, as stated above, has 11 chromosomes which we might label *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, and *k*. An egg cell of this same kind of plant has 11 chromosomes which are similar and could legitimately be labeled from *a* to *k* when the egg and sperm fused, there is a random assortment of these two sets of chromosomes in the zygote, and this is continued throughout all vegetative or somatic cells, to and including the mother cells of the anthers and ovules. However, at this point, the chromosomes become assembled in pairs within the mother cell nucleus, *a*, pairing with *a*, *b* with *b*, and so on through the *k*-pair. As division continues, the members of each pair of chromosomes separate, moving to opposite poles, with a wall eventually separating the two groups. The two new cells have half the number of chromosomes found in the mother cell. If this is occuring in the anthers, the end result will be male gametes; if in the ovule, the egg cells will develop. The diploid phase starts again upon fusion of a sperm and egg.

However, if one of the sets of 11 chromosomes, let us assume, form the egg, were sufficiently different that we would have to label them *p*, *q*, *r*, *s*, *t*, *u*, *v*, *w*, *x*, *y*, *z*, pairing of the chromosomes previous to the reduction divisions usually will not take place, and the cells abort. Ordinarily no fruit or seeds can develop. This is what apparently happens in the common Day-Lily (*Hemerocallis fulva*, clone *Europea*), (fig. 25). This Day-Lily was introduced from Europe perhaps over a century ago. Although no fruits or seeds ever develop, it propagates readily from the rhizomes. It is found thoroughly established along roadsides and railroads in every county in Ohio—dumped there as waste from someone's garden.

The seedless fruit varieties of orange, grapefruit, pineapple, banana, grapes and persimmons are further examples of sterility because of irregularities in gamete formation, but differ from the Day-Lily in that the pistil of the flower, although sterile, does not abscise, but continues to grow and matures as a seedless fruit. Such plants cannot survive in the wild, without the aid of man.

As stated previously all cells of the vegetative parts of a seed plant ordinarily are diploid, established by the fusion of the two monoploid gametes. The diploid, number is maintained by the mitotic cell divisions. In this kind of division, the chromosomes set is duplicated in every division. Occasionally an accident happens which prevents the formation of a new cell plate and the duplicated chromosomes remain together in one cell. The diploid number is doubled by this method and the cell is a tetraploid. If this accident should occur as the zygote divides then every cell of the embryo, seedling and mature vegetative individual will be tetraploid. If it occurs in one cell of a two-celled embryo then the shoot may be tetraploid and the root diploid, or vice versa. If it occurs in a somewhat older embryo, then only that portion of the shoot derived from the original tetraploid cell will have the $4n$ number of chromosomes with other parts remaining diploid. This tetraploid state may occur spontaneously or it may be induced by treatment with colchicine and a few other reagents. Tetraploid plants, in general, may have thicker leaves, larger stems and increased size of the flowers, fruits and seeds. Such plants are usually slower in growth, and consequently are later in flowering and fruiting. The Burpee Seed Company has been advertising tetrasnapdragons and marigolds for several years.

Somewhere in Western Mexico, the tetraploid condition developed in the annual teosinte mentioned previously. The tetraploid plant has 40 chromosomes and is a perennial. The annual teosinte has 20 chromosomes. The tetraploid form has been described as a new species.

Some nurseries list as available a hybrid Horse Chestnut (*Aesculus carnea*). It is a tetraploid, having 80 chromosomes and will "come true" from seed. It is known to have resulted from a cross between the Horse Chestnut (*Aesculus hippocastanum*) with 40 chromosomes and the Red Buckeye (*Aesculus pavia*),

26. Ulrey's variegated African Violet.
27. A variegated specimen of Orchid Wonder variety of African Violet.
28. Mme. Selleroi Geranium.
29. Silver Leaf, S. A. Nutt Geranium.

also having 40 chromosomes. With the exception of one case the hybrids were sterile. In the one instance doubling of the chromosomes must have occurred, resulting in a complete set of Horse Chestnut chromosomes and a complete set from the Red Buckeye in the hybrid zygote. The chromosomes at meiosis could pair and separate in the usual way, and the usual segregation in a hybrid was prevented. This illustrates how a new species may be synthesized through hybridization and the doubling of chromosomes.

The bread wheat, as mentioned earlier is thought to have arisen in the region of ancient Babylonia. Bread Wheat has 42 chromosomes. Emmer (*Triticum dicoccum*) with 28 chromosomes, another wheat somewhat useful as livestock feed, crossed with a noxious weed, Goat Grass (*Aegilops squarrosa*) with 14 chromosomes, and became the parents of the world's most valuable food plant! This must have occurred by the doubling of the chromosomes in the zygote (fertilized egg) or by the fusion of two unreduced gametes, giving the same result. This kind of heritable variation is by no means uncommon, as one might be led to believe from the above illustrations. It is probable that similar changes were involved in the origin of such domesticated plants as the Potato, Sugarcane, Brome Grass, Cotton, Tobacco, Oats, Apples, Pears and Strawberries.

MUTATIONS

In addition, new, unpredictable, heritable changes in plants may occur, known as gene mutations. Genes are invisible units of the chromosomes, each with a potentiality which may become expressed as an observable characteristic of a plant or animal. Ordinarily genes are stable, remaining unchanged through many generations bridging millions of years. At the other extreme, there are genes which are unstable and mutate frequently in the same way. An illustration of this is found in a corn variety known as "Variegated Pericarp" or "Calico". This maize variety is characterized by the pericarp of the grain being finely variegated with red stripes orientated lengthwise of the grain. Each red stripe or sector is the result of a mutation as shown by Emerson 1914, 1917, and studied recently by Anderson and Brink 1952. Occasionally grains were found which had an entirely red pericarp. The gene controlling the red color is stable, since when red grains are planted every grain on the ear borne by the plant from the red grain, are red. For about 10 years, the writer has had a strain of Calico maize in culture for another purpose. During that time four ears have been found, each with a block of grains with colorless pericarp (fig. 23). When these colorless-pericarp grains are planted, ears are borne every grain of which is colorless. This may represent a mutation in the unstable gene to one that is stable as far as colorless pericarp is concerned.

Mutations may occur in the formation of gametes, or in any living vegetative or somatic cell. In vertebrate animals and in some plants, mutant cells in somatic or vegetative tissues are lost with the death of the individual or at least death of the organ in which it occurred. This has given rise to the too common notion that mutations only occur in the formation of gametes. No techniques are known at present by which pieces of somatic tissues or organs of vertebrate animals or the vegetative organs of some plants can be used in the propagation of such organisms. However, most seed plants may be propagated vegetatively from leaves, stems, or roots. A mutant cell in any one of these organs then has chance at survival, providing the organ is placed in proper conditions which will lead to vegetative multiplication.

If a mutation occurs in a gamete or in the fertilized egg every cell of the embryo is identical to the zygote, as far as chromosomes and genes are concerned. This continues to be true for all cells of the seedling as well as the mature plant. This was mentioned earlier when dealing with growth and development of maize zygotes. Ordinarily when this happens, the mutant individual may be found among many

FIGS. 30–32. Mutations from a splotched leaf type of variegated *Coleus*.

individuals of the parent type which do not exhibit the change. An example of such a mutant is illustrated by (fig. 26) Ulrey's variegated *Saintpaulia* (African Violet). This variegation is due to a chlorophyll deficiency in the young leaves, and is gradually lost as the leaves become older, with old leaves often being entirely green. More variegated plants may grow vegetatively from leaf-cuttings.

Previously it was mentioned that mutations may also occur in any vegetative or somatic cell. This may be illustrated by the African Violet variety sold as "Orchid Wonder". The leaves of this variety are ordinarily dark green in color. The plant illustrated by figure 27, grew vegetatively from the petiole of a detached leaf of the Orchid Wonder variety when placed in moist sand. The chlorophyll deficient tissue resulted from a cell which mutated in the stem primordium which developed near the cut end of the petiole of the detached leaf. As the stem primordium grew, the mutant cell increased in numbers and the chlorophyll deficient tissue became distributed in many of the leaves seen in the illustration. Each variegated leaf then is made up of two genetically different tissues instead of one, as is usual. When variegated leaves of this African Violet, are used as propagules, the young plants are usually green as typical of the original parent, or they are so chlorophyll-deficient that adequate sugar is not made and they soon die of starvation. The variegated state can be propagated from stem cuttings but this is difficult, and not practical since the internodes of the stem are very short and ordinarily there is only one terminal, vegetative bud. The lateral or axillary buds ordinarily are inflorescence buds and their growth is determinate. Similar mutants have been observed in plants derived from leaf cuttings in varieties sold under the name of "Mentor Boy", "Red Head Girl" and "White Lady". The same kind of mutation has probably occurred in many varieties of *Saintpaulia*.

In most variegated plants, the stem internodes are much longer than in *Saintpaulia* and the axillary buds are more likely to be vegetative rather than reproductive. Examples of this will be recognized in the common varieties of Geranium (*Pelargonium*) and *Coleus*. In such examples numerous *stem* cuttings may be made from a single plant. If these stem cuttings are chimaeras, then the chimaeral or variegated condition may be propagated. Mutant tissues in a chimaera may be distributed in a plant organ in one of three ways: (1) Periclinal, (2) Sectorial, and (3) Mericlinal. The periclinal chimaeras are the most stable of the three types. This one is characterized by the mutant tissue forming a solid sheath about the whole organ. The red skin of a Red Triumph potato tuber (fig. 38 a-b) is an example. The sectorial type (fig. 39, 40) is the least stable as far as the chimaeral condition is concerned. The mericlinal type is characterized by an uneven distribution of the mutant tissue in the organ, forming streaks, splotches or mosiac patterns. The mericlinal type is less stable than the periclinal, but more permanent than the sectorial form. Most variegated ornamental plants fall in this class.

The variegated Geranium (*Pelargonium*) listed as "Silver Leaf, S. A. Nutt" (fig. 29) is a fairly stable chimaera exhibiting albino tissue about the border of the leaf-blade. When branched plants are cut back and lateral buds are forced to develop, occasionally a stem is found which bears green leaves with no variegation (fig. 29). Less frequently an albino branch may develop laterally from a larger stem which bore typically variegated leaves. Cuttings from the green branch will multiply vegetatively and continue to be entirely green. Cuttings from the albino branch will not survive because of the lack of sugar.

Another variegated Geranium (*Pelargonium*) variety "Mme. Salleroi", has a chlorophyll-deficient (yellow-green) area radiating from the petoiole-end into the leaf blade (fig. 28). This variegated condition ordinarily is quite stable. However, figure 28 illustrates a plant which has a completely green branch and one which is chlorophyll deficient, in addition to branches which have typically variegated leaves. Cuttings from the green branch will reproduce vegetatively, continuing to be green, and presumably like the parent of this variegated variety.

Cuttings from the mutant yellow-green branch will root and continue to grow with all new leaves and branches having the chlorophyll-deficient color. It is less vigorous and more care is necessary in keeping conditions right for growth.

The above two Geraniums (Silver-Leaf, S. A. Nutt and Mme. Salleroi) illustrate how mutations occurring in vegetative parts may result in chimaeras. The mutation may have occurred but once for each variety, many years ago and the

Fig. 33. *Sansevieria trifasciata.*
Fig. 34. *Sansevieria trifasciata,* var. *Laurentii.*
Fig. 35. *S. trifasciata* shoot developing from a leaf-cutting of var. *Laurentii.*
Figs. 36–37. Yellow shoots originating from yellow tissue of a leaf-cutting of var. *Laurentii.*

mutant chimaeral or variegated state has been maintained by vegetative multiplication. Most variegated plant varieties may be used to demonstrate a mutant individual. The exceptions are found in some varieties which have genetic patterns characteristic of some *Coleus* varieties, and albino spots, blotches or streaks due to viruses as in *Abutilon pictum* (Flowering Maple). The Geranium specimens illustrated in figures 28 and 29, demonstrate vegetative or somatic segregation of the mutant tissue from the chimaera as well as segregation of the original type—the green branches. Obviously meiosis is not involved in this segregation, but is due to fortuitous anatomical deviations. For centuries man has been taking advantage of these vegetative or somatic segregates ("sports" of the older horticultural literature) without much of an understanding or appreciation of how

they came about. It has been of great importance in obtaining new and useful plant varieties not only among ornamentals, but most modern varieties of apples, pears, grapefruits, oranges, peaches, grapes and many others.

An unnamed variegated *Coleus* variety, with leaves characterized by a dark red background with flecks of yellow distributed without any particular order or constant pattern, was maintained in culture for several years. From one plant a branch developed which bore completely red leaves (fig. 30). Cuttings from this branch have continued to be dark red in color without any indication of yellow flecks. Figure 31 is a photograph of a plant of the same variety exhibiting a yellow-leafed branch. The yellow branch propagated vegetatively, and continued to be entirely yellow, with the characteristics of the commercial Golden Bedder variety. A third mutation was observed from the same unnamed variety and is illustrated by figure 32. The mutant branch bore leaves which were red with a yellow border around the edge of the leaf-blade. Several similar mutations resulting in chimaeras, have been found in *Coleus*.

The vegetative or somatic segregation of mutant tissues from a chimaera often is not as readily accomplished as in Geranium and *Coleus*. Special methods may have to be employed as described below for potato and *Sansevieria*. Some years ago it was noted that in the common potato variety, "Red Triumph" tubers could be found which had irregular white areas surrounded by the usual red skin, as illustrated by A and B of figure 38. This seemed to indicate that at least these particular tubers were chimaeras, usually of the periclinal type, but by some anatomical deviation, the mericlinal form might develop, as shown for those with white areas in the skin. No bud was found isolated in the white areas which was free of the red pigment. Since the potato is propagated vegetatively from tuber-cuttings having at least one "eye" or bud, it seemed probable that the red-skin character was transmitted to the new vegetative generation by the outermost layers of embryonic cells in the stem tip of the bud. To shorten a long story, the stem tips on numerous cuttings were "peeled" and planted. Some cuttings survived the peeling treatment and developed as usual-appearing potato plants, except for being slower in sprouting. In late summer when the tubers were harvested from the treated plants, most plants bore tubers all of which were variegated, and were interpreted as being mericlinal chimaeras. These probably resulted from incomplete removal of all red tissue from the embryonic stem tip at the time of peeling. A few plants bore tubers all of which were *white* (fig. 38 C) including the "eyes" or stem tips. During the following summer, cuttings from the white tubers were planted, all of which developed plants bearing "White Triumph" potatoes. Two other varieties, "Blue Victor" and "Blue Meshanoc" have been treated in a similar way, resulting in a "White Victor" and a "White Meshanoc" potato.

Bowstring-Hemp or snakeplant (*Sansevieria trifasciata*) (fig. 33) has been in cultivation as an ornamental for more than a century and as a fiber plant in Africa for a much longer time. About fifty years ago a variegated form, characterized by a golden-yellow border around the leaf-edge, was found in cultivation by a native tribe in the Belgan Congo. It was named *Sansevieria trifasciata* var. *Laurentii*, and is usually listed on the floral market as *S. Laurentii* (fig. 34). This variety is more popular today as a decorative plant than is the species. The species (fig. 33) could propagate vegetatively from leaf-cuttings as well as from rhizome pieces having a stem tip. Soon after the variegated variety (*Laurentii*) was introduced as a house-plant it was learned that the variegated form could be propagated only from rhizome cuttings. When leaves are used as propagules, non-variegated plants will result from them which are like the species as illustrated in figure 35. This led to the inference that *Laurentii* is a chimaera with two genetically different tissues. That is the golden-yellow tissue, forming a border to the leaf, is genetically different from the green tissue. To test this inference, leaf cuttings were made as illustrated in figure 36. This was done because roots

develop from the cut end when in contact with moist sand. However, ordinarily roots develop only from the green tissue of the leaf cutting and not from the yellow tissue. New shoots or stems initiate at the base of a root about where the root originates from the leaf tissue. A block of all-green tissue was removed from the area of the leaf cutting which was to be set in moist sand, with only strips of yellow tissue in contact with the substrate. Roots, after some time, developed from the yellow tissue and eventually golden yellow shoots as illustrated in figures 36 and 37. At first the shoots are slightly green, indicating the presence of some chloroplasts, but these soon disintegrate and the tissues become golden-yellow

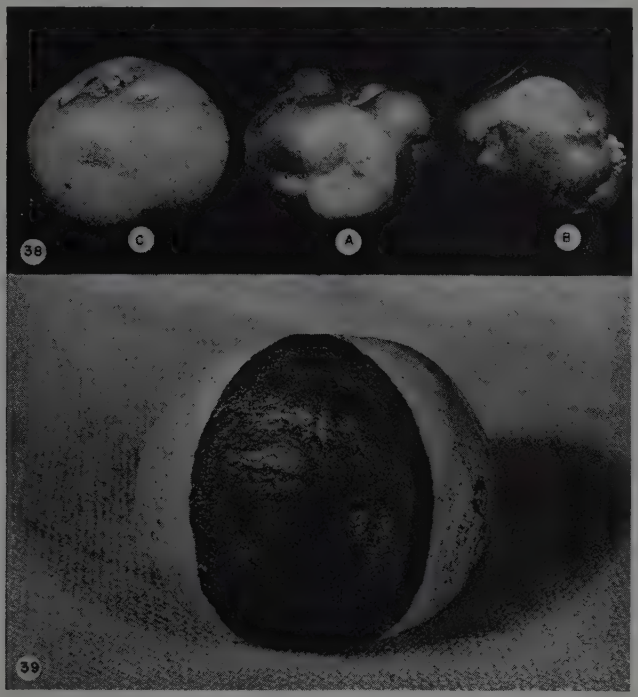


FIGURE 38. A and B, Chimaeral tubers of the Red Triumph Potato. C, White tuber which resulted from peeling a bud from Red tuber used as a propagule.

FIGURE 39. A sectorial chimaera of grapefruit.

in color. If the rhizome connection between the yellow shoot and the leaf-cutting is broken, the shoot dies of starvation within about two weeks. This is presented as evidence that the yellow tissue is genetically different from the green. The yellow tissue is mutant tissue which has existed in a chimaeral relationshup with green *Sansevieria* tissue, perhaps much longer than the fifty years since the French botanist Laurent, discovered it in cultivation by natives of the Belgan Congo. It is only by accident, or when special technique as described above is applied, that segregation of the pure yellow mutant tissue results in chlorophyll deficient plants.

Mutations resulting in sectorial chimaeras may occur in leaves, stems, roots, inflorescences, flowers and fruits. The grapefruit illustrated by figure 39 had

a relatively large sector of the fruit coat or pericarp which was dark brown in color in contrast to the light yellow color of the remainder of this particular fruit. No differences were observed in the carpels containing the pulp oposite the brown sector of the pericarp and those opposite the yellow part of the fruit coat. The inference from this and other evidence was that only the sector of the pericarp was affected by this mutation and that the carpels and seeds opposite the brown sector were not changed. Similar sectoring is fairly frequent in oranges, lemons and grapefruit.

Sectorial chimaeras in fruits are not always superficial, *i.e.*, limited to the pericarp. Several years ago a tomato fruit of the Baltimore variety (fig. 40) was found in a field, which had a sharply outlined yellow sector with the adjoining parts of a deep red color. Eventually a cross-section of the fruit was made in order to examine the extent of the yellow mutant tissue of the sector. It was readily evident that the yellow tissue extended to the center of the fruit and included two seed cavities.

FIGURE 40. A sectorial chimaera of a tomato fruit.

FIGURE 41. Plants from seed of the yellow sector (fig. 40) bore yellow tomato fruits, while those from the red portion of the chimaera continued to bear red fruits—second fruit from left.

Seeds from the yellow sector were saved as well as those from the red portion of the fruit. Three plants from seeds of the yellow sector, matured and bore yellow fruits (fig. 41). Descendants from these three plants have been carried through ten generations with the matured fruits of each generation continuing to be yellow.

Seeds were also saved from the red portion of the chimaeral fruit (fig. 40) and planted. All the progeny bore red fruits. Two lines were selected from these red-fruited plants as sources of seed. Descendants of these two plants have been planted for ten generations with no segregation of yellow fruits having been observed and no more fruits have been found with yellow sectors.

Yellow fruiting plants were cross-pollinated with red fruiting plants. The hybrid plants (F_1 Generation) all bore red fruits as might be anticipated from results upon crossing other varieties of red and yellow tomatoes, and illustrates the dominance of the red color factor over yellow color. Seeds were obtained from self pollinated hybrids and planted. Out of a group of 59 plants, 45 bore red fruits and 14 were yellow fruited, working out as a simple Mendelian 3:1 ratio.

Although no other sectorial chimaera has been reported for fruits, from which the mutant character is transmitted by seed, it probably does occur and usually escapes unnoticed. This suggests another plant organ and place in the life cycle worthy of close observations, where mutants may be discovered.

This story of the domestication of plants is a story of how man has and is now making use of the products of evolution which are desirable to him. The world is represented in our gardens, orchards, and fields by many domesticated plants, necessary in our daily activities and well being. Achievements have been considerable in the past, and there still remains a great reservoir of unexplored plant potentialities.

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Introductory Mycology. *Constantine John Alexopoulos.* John Wiley & Sons, Inc., New York. 1952. xiii+482 pp. $7.00.

With an ever increasing interest in the fungi, there has developed a great need for a suitable introductory textbook in Mycology. *Introductory Mycology* has been written for the student who is beginning his study of the fungi and as the author states for one "who needs an orderly presentation of certain fundamental facts on the structure and classification of these organisms in the form of broad concepts and patterns, without the innumerable details and exceptions which make the study of fungi so fascinating for the specialist, but so bewildering for the beginner." The book includes one chapter on the bacteria, which in a text in Mycology is unusual, but certainly not out of place. In another chapter the slime molds are discussed while the remaining 15 chapters are devoted to the various groups of fungi including one short chapter on the lichens. Well selected references are included at the end of each chapter. A glossary of mycological terms with their derivations is included. The derivations of these terms are also found in the text when the word is first used.

The text is well illustrated with excellent photographs and line drawings expertly done. An outstanding feature is the inclusion of illustrated life cycles of many of the fungi and slime molds discussed.

The book reads easily and should excel as a text for introductory courses in Mycology. The author is Professor of Botany and Plant Pathology at Michigan State College.

C. W. Ellett.

The September Number of The Ohio Journal of Science will contain

THE TRAPPING OF SOLAR ENERGY

A Symposium presented at the annual meeting of the Ohio Academy of Science held at Kent State University, Kent, Ohio, April 18, 1952.

DR. EDWARD M. REDDING—*Chairman*
DR. CHARLES F. KETTERING—*Honorary Chairman*

INTRODUCTION ..... William M. MacNevin
SOLAR RADIATION ..... John H. Shaw
HEATING OF AIR BY SOLAR ENERGY, George O. G. Löf and Thomas D. Nevins
PHOTOSYNTHESIS ..... Paul Rothemund
THE UTILIZATION OF THE SOLAR ENERGY THROUGH PHOTOCHEMICAL REACTIONS ..... Jack G. Calvert
PHOTOVOLTAIC CELLS AND THEIR POSSIBLE USE AS POWER CONVERTERS FOR SOLAR ENERGY ..... Dan Trivich
THE USE OF OPTICAL SYSTEMS IN THE UTILIZATION OF SOLAR ENERGY ..... J. Allen Hynek

Copies of the September Number containing the papers in the Symposium may be obtained from the Business Manager of the JOURNAL at $1.00 each.

An Introduction to Scientific Research. *E. Bright Wilson, Jr.* McGraw-Hill Book Company, Inc., New York. 1952. xiii+375 pp. $6.00.

The text outlines the logical steps one takes in pursuing scientific research. The chapters are devoted to problems and procedures in the following topics: the choice and statement of a research problem (both pure and applied); searching the literature (with an analysis on the structure of scientific literature); scientific methodology; design of experiments; design of apparatus; execution of experiments; classification, sampling, and measurement; analysis of experimental data; errors of measurement; probability, randomness, and logic; mathematical work; numerical computations; and reporting the results of research.

While the material is presented as a progressive and continuous account for teaching purposes, each section is so organized that it can be studied for review or reference reading as an independent unit. The content leans heavily toward the physical sciences and is concerned largely with laboratory and experimental methods. However, the general principles and techniques are applicable to a wide range of the sciences. In the biological fields, this book is most suitable for students preparing for physiological research. There is no specific treatment of the descriptive sciences or field sciences. A few sections, such as the design of apparatus, are devoted entirely to laboratory physical science. This emphasis would be expected from an author who is a specialist in physical chemistry (Theodore William Richards, Professor of Chemistry at Harvard University).

The book is oriented around quantitative studies with emphasis upon practical problems and their solution rather than philosophical discussion. Fundamental and universal theories of research are stressed. A knowledge of mathematics is needed to understand many sections although much of the basic discussion is non-mathematical. Sources and references are given at the end of each chapter. Illustrations consist of diagrams, graphs, and tables. There is a complete index. Interesting and amusing anecdotes throughout add a touch of humor to a weighty subject as well as illustrate the case in point. This would be a good text for a graduate seminar in experimental laboratory sciences.

RALPH W. DEXTER.

JOHN HECKEWAELDER'S 'TOADS' (APRIL 25th, 1773)

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In the pursuit of a far-reaching mission plan of the Moravian Church, to move all its Indian converts out of Pennsylvania and across the Ohio, a new mission field was opened, in 1771, among the friendly Delaware (or Lenni Lenape) Indians, in the Muskingum basin. In 1772, the Rev. David Zeisberger, Moravian head missionary, founded two mission stations on the Tuscarawas River, Schönbrunn and Gnadenhütten; and, in the the spring of 1773, John Heckewaelder, assistant missionary under Zeisberger, was commissioned to conduct, by water, a consignment of Indian converts from the mission of Friedensstadt, on the Great Beaver, in northwestern Pennsylvania, to the Tuscarawas missions. From April 13th to May 5th, 1773, he traveled, with his charges and their belongings in twenty-two canoes, down the Great Beaver and the Ohio, and then up the Muskingum and the Tuscarawas, to their final destination, Schönbrunn, near present-day New Philadelphia (Tuscarawas Co., Ohio).

John Heckewaelder's travel diary covering this river journey is extant; a manuscript, in the possession of the Moravian Archives, at Bethlehem, Pennsylvania. Written in a lively and personal German, it makes fascinating reading and provides much valuable information.

Being occupied, these days, with preparing it for publication, in both German and English, together with a series of other Moravian mission diaries, I came upon an entry which not only aroused my personal curiosity but may also be of interest to the readers of a science journal; especially, to students of local fauna and ecology.

The general situation of those river travelers, on April 25th, 1773, when Heckewaelder made that diary entry, was this: They had worn themselves to a frazzle, during the morning hours, dragging and shoving their canoes through shallow channels of the river. Hence, they decided to rest for the remainder of the day. They made camp for the night "near a huge rock" (the site of which could be located about halfway between Luke Chute Dam and Brokaw, on the east bank of the Muskingum). In true Indian fashion, some of them "at once built a sweating -oven to sweat out their fatigue; . . . others went out hunting a little and encountered buffaloes at which they shot but without success."

Now follows the part of Heckewaelder's diary entry, which aroused, not only my curiosity, as I have said, but also my exploring spirit. I quote: "This night we did not find much rest because of the vast number of toads [*Kröten*], which greatly annoyed us. The [Lenape] Indians, therefore, call this place *Tsquallutêne*, that means, 'town of the toads.' About midnight, we had a terrible thunderstorm accompanied by heavy rain."

Of what species may these toads have been? Or were they not toads at all, but frogs? People frequently do not discriminate between 'toads' and 'frogs.'

I decided to find the answer to my question by local inspection; provided, of course, that not too radical a change in the nature of the habitat had taken place, since Heckewaelder's days, making the mere attempt to appear unreasonable. In any event, I was determined to go and see.

After having trained my ear, to distinguish the calls of various species of both toads and frogs, with the aid of excellent recordings, kindly lent to me by Dr. Edward S. Thomas, Curator of Natural History, The Ohio State Museum, I visited, in the afternoon of April 25th, 1952, the area where, most likely, Hecke-

waelder and his Indians had made their night camp, in 1773, and under very similar weather conditions, at that; only that, *this* year, there had been heavy rain in day-time. There still were dissolving rain clouds in the sky when, shortly before 7:00 P. M. (EST), I set out, on foot, from the farm-house, high above the Muskingum valley, of Mr. and Mrs. Clarence Walker, to whom I am unendingly grateful for their wonderful kindness in extending to me the most gracious hospitality in their home, at an easy walking distance from the place, by the river,

FIGURE 1. Map section showing the Madison Run flats west of Brokaw (Windsor Township, Morgan County, Ohio).

which I intended to visit. I also wish to express my deep gratitude to their daughter, Miss Louanna Walker, for having piloted me through the poorly mapped hills west of Waterford, where, without her competent initiative, I should have been hopelessly lost.

The place where Heckewaelder had his camp is roughly the site of present-day Brokaw, a small village of a few houses, in Windsor Twp., Morgan Co.; here,

the steep rocky proclivity which closely hugs the east bank of the Muskingum upstream from Luke Chute Dam sufficiently recedes from the river to make room for a camp site. All along the foot of that low terrace, there extend swampy flats formed by Madison Run which, coming from the south, here empties into the Muskingum (fig. 1, *U. S. Geol. Surv. Map*, State of Ohio, Caldwell Quadrangle, extreme SW section). Especially after heavy rains, these flats are very soggy with countless puddles and rills, making an ideal spawning ground for toads and frogs. The entire expanse, moreover, is loosely covered with shrubby willows. Except for the railroad dam that traverses these flats, from east to west, at Brokaw, close to, and almost parallel with, the river, the swampy bottom appears not to have been disturbed between 1773 and the present day.

Based on the supposition that, therefore, its fauna likewise has remained essentially unchanged, my expectations were fully borne out: starting at twilight (about 7:30 P.M. (EST)), and ever increasing in both volume and shrillness as darkness deepened, there rose from the swamp a batrachian chorus nothing short of ear-splitting. Not a single *toad's* typical call was heard, however; it was a pure chorus of *Hyla crucifera crucifera* Wied., the Spring Peeper, a tree-frog, which, by the way, is called a 'toad' by the people of the region. This misnomer confirms my belief that Heckewaelder, at least in the case at hand, likewise failed to discriminate between 'toad' and 'frog.' It is certain that his Lenape Indian converts did not either since their language has but one word, *tsquall*, for both 'toad' and 'frog'; it appears in the name, *Tsqualluténe*, by which the place was known among them, presumably from former experience. Heckewaelder's added explanation of the name, "das ist das Kröten *Town*" (he uses the English word 'town' in his German), clearly implies the meaning 'town of the toads,' which is likewise a connotation of the Lenape name. Were it meant to denote 'a human settlement (town) named after toads,' it would be *Krötenstadt* (-town), in German, and *tsquallutén-ünk* (with place-name suffix, -ünk [-üng, -ing]), in Lenape (Unami dialect).

Another observation made, that night, in the Madison Run flats helps to disclose the nature of the annoyance caused the campers of 1773 by "the vast number of toads": Some of the creatures, after but the briefest interruption, continued their singing, with the full glare of my flashlight close upon them; yet, not a single one could be seen; not a single one fled at my approach and jumped into the water, as other kinds of frog usually do. That permits the inference that the sleep of the weary travelers was disturbed solely *by the noise* of those Spring Peepers; for it seems out of the question that this particular kind of frog "annoyed" them by hopping or crawling about the camp.

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A CHANGE IN EDITOR OF THE JOURNAL

Dr. Earl L. Green has recently resigned as editor of The Ohio Journal of Science, after two and one-half years of service, to take up temporary duty with a government agency while on leave of absence from The Ohio State University.

The new Editor-in-Chief is Dr. Richard H. Böhning of the Department of Botany and Plant Pathology of The Ohio State University.

The editorial policy of the Journal will continue in the pattern established by previous editors. The Journal will welcome and publish papers in all fields of science. The papers may be either technical reports of new research, or expository and descriptive papers on aspects of science of general interest.

THE OHIO JOURNAL OF SCIENCE AWARD FOR EXCELLENCE IN RESEARCH

The Ohio Journal of Science will offer awards to persons presenting outstanding original research papers in fields of science represented by sections of The Ohio Academy of Science. For the current year the field of geology has been chosen by the Joint Administrative Board of The Ohio Journal of Science.

AWARD

The award for 1954 is $150.00 for the outstanding paper selected in the field of geology.

ELIGIBILITY

1. All participants must be members of the Geology Section of The Ohio Academy of Science.
2. The manuscript must be either (a) unpublished or (b) published in the Ohio Journal of Science after July 1, 1953.
3. The manuscript must be based upon original research conducted by the participant or participants.
4. The following are not eligible participants: members of the editorial or management staff of The Ohio Journal of Science, members of the Joint Administrative Board, members of the Committee of Judges.

RULES

1. Two copies of each manuscript complete with figures or photographs of figures or two reprints of papers already published in The Ohio Journal of Science must be submitted to the Editor on or before January 1, 1954.
2. If unpublished, the manuscript must be in a form suitable for publication.
3. The right to publish any or all of the unpublished manuscripts submitted, whether prize-winning or not, shall remain with The Ohio Journal of Science until one month after the 1954 meeting of The Ohio Academy of Science. On or before this date, the Editor of The Ohio Journal of Science will return to the authors those manuscripts which he does not choose to publish in The Ohio Journal of Science. Authors of these papers will then be free to publish the results of their research anywhere they choose. At the same time the Editor of The Ohio Journal of Science will inform the authors of those papers which the Editor wishes to publish in The Ohio Journal of Science of this fact, and will set an approximate publication date which will not be later than May 1, 1955.
4. A summary of the paper is to be presented by the author at the 1954 meeting of The Ohio Academy of Science unless the paper has already been published in The Ohio Journal of Science, or unless the program committee of the Geology Section finds it not feasible to do so.

SELECTION OF AWARD WINNERS

1. The Vice President of the Geology Section of The Ohio Academy of Science will choose a Committee of Judges composed of three or more members qualified to judge the manuscripts submitted. The Vice President will designate one of the judges to serve as chairman.
2. The Editor of The Ohio Journal of Science will transmit the manuscripts and reprints submitted to the Committee of Judges.
3. The Committee will select the award winner. The Committee has the obligation to refuse to make an award if, in its opinion, none of the manuscripts is sufficiently high in caliber to be so honored.
4. The winner of the award will be announced at the Annual Banquet and Business Meeting of the Academy in 1954.

CURRENTS IN LAKE MENDOTA, WISCONSIN

JAMES L. VERBER, R. A. BRYSON, AND V. E. SUOMI

F. T. Stone Institute of Hydrobiology, Put-in-Bay, Ohio, and Department of Meteorology, University of Wisconsin, Madison

The currents of Lake Mendota have been measured by using free floating vanes during the year 1949 to 1950. Observed velocities ranged from less than one meter per minute to 20 meters per minute in 60 feet of water. These velocities are not unusual and do not include those currents which may be even faster but found only during stormy periods.

According to the Ekman theory, application of a wind stress to a water surface will produce a net transport of water to the right of the wind. The distribution of velocity involved in this transport varies in the vertical as given by the Ekman spiral (Sverdrug, 1946). The surface current has maximum velocity and is directed about 45° to the right of the wind, while at greater depths the current turns more to the right and its speed decreases. Near the bottom of the friction layer the current is supposed to move opposite to the wind direction but with low velocity. This theory supposes a balance of forces, however, at our latitude, the time constant of a current system which is out of balance is longer than the interval between changes in the wind stress. Thus, with our variable winds we can expect unbalanced conditions prevailing most of the time. Only in periods of prolonged calm should we expect the pressure gradient force, gravity force and coriolis to be in balance.

WIND STRESSES AND SOLENOIDS

During periods of stratification the effect of this unbalanced wind stress on the surface is to drive warm surface water downwind. The speeds attained by these wind-driven currents are usually sufficient to move the upper five meters of water across the lake in about one day (table 1). This accumulation

TABLE 1

Time required to cross a 5 Km wide Lake

Current Speed—meters/min	Time—hours
1.0	83
2.0	41.6
2.8 (Ave. at 10 m depth)	29.6
3.0 (Ave. at 5 m depth)	27.8
4.0	20.9
4.1 (Ave. at 1 m depth)	
5.0	16.7
10.0	8.3
15.0	5.6
20.0 (Fastest observed)	4.2

of warm water downwind which is replaced by upwelling colder water upwind results in the production of pressure-temperature solenoids. This upwelling of cold water was demonstrated by Church (1943). The action of the wind in this respect is similar to the winding of a spring. When the wind stress ceases this spring unwinds and the cold water tends to return to its stable position under the warmer water. Thus, the wind produced solenoids represent an accumlation

of potential energy which, when the wind ceases, will cause the wind-driven currents to stop and reverse. On the 8th of July 1949 the wind was from ESE at 10–15 mph, producing a current towards the NW at 5 meters per minute. The 11th of July was calm, but the current at the same spot was towards the south 3.3 meters per minute.

The hypolimnion is protected from frictional stress by the great stability of the thermocline, but not from pressure changes due to weight changes within the epilimnion. Consequently solenoids will be produced but the circulation should be dominantly thermal rather than alternating between mechanical and thermal as in the epilimnion.

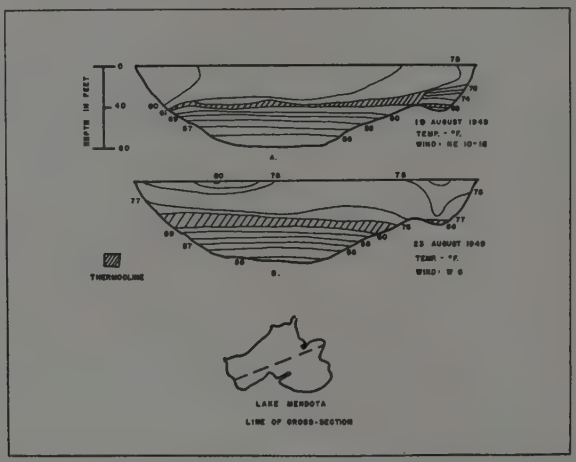

FIGURE 1. Orientation of the cross-section is northeast-southwest, from Mendota Beach to a small bay off Governors Island. Interval for the isotherms is 1° F. Note how the thermocline is stipped off in A.

QUALITATIVE ASPECTS

As soon as the top layer of water has been driven downwind, horizontal temperature difference must prevail. The isotherms then move with very nearly the speed of the current, and relative currents must deform them. By this fact it is possible to estimate the location of tongues of higher velocity, regions of convergence and divergence, and large eddies from the charts of temperature. Certain interesting conclusions may be reached by study of cross-sections of temperature figure 1.

1. Changes in the structure of the lake from day to day are frequently observed which are greater than can be accomplished by horizontal currents alone. This means that vertical currents must play an important part.

2. On some of the vertical sections, temperatures appear in the upper epilimnion which the day before were only found in the uppermost part of the thermocline. Figure 1A shows how this action takes place. The thermocline itself thickens considerably in regions where upwelling might be expected in the epilimnion and thins in regions of sinking. It is hard to say how these changes could take place unless the wind-induced currents in the epilimnion also produce movement of water in at least the upper part of the thermocline. The cross-sections indicate that the top layer of the thermocline may be actually stripped off, carried

to one side of the lake and there brought to the surface. However, this occurs only under rather extreme conditions. The biological consequences of this movement must be considerable.

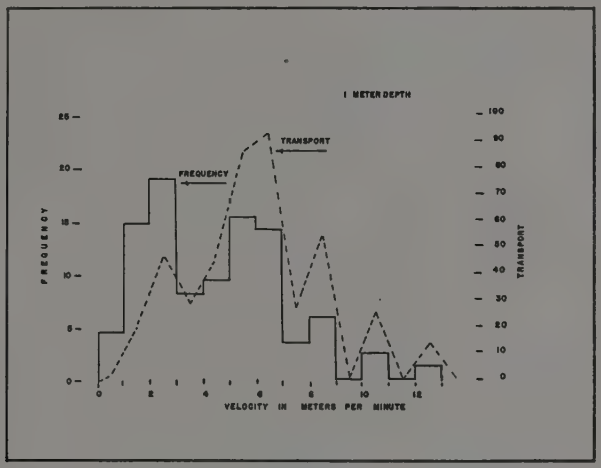

FIGURE 2. Frequency and transport of currents at 1 meter depth, July, 1949. 102 velocity and direction measurements.

QUANTITATIVE ASPECTS

In table 1 are listed the average velocities observed at various depths and the number of hours required to cross large parts of the lake at these velocities. The currents in the epilimnion ranged from 2 to 6 meters per minute and those

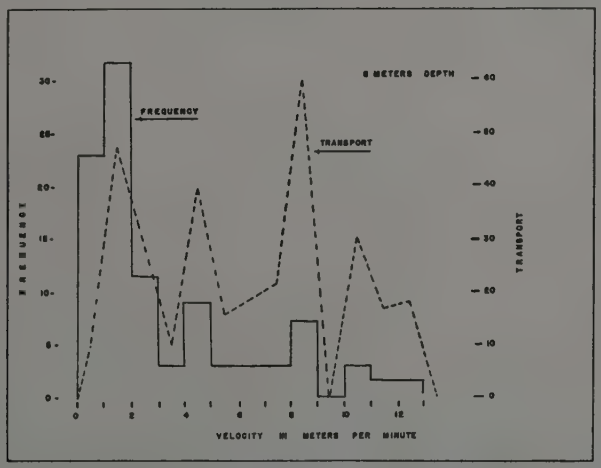

FIGURE 3. Frequency and transport of currents at 5 meters depth, July, 1949. 102 velocity and direction measurements.

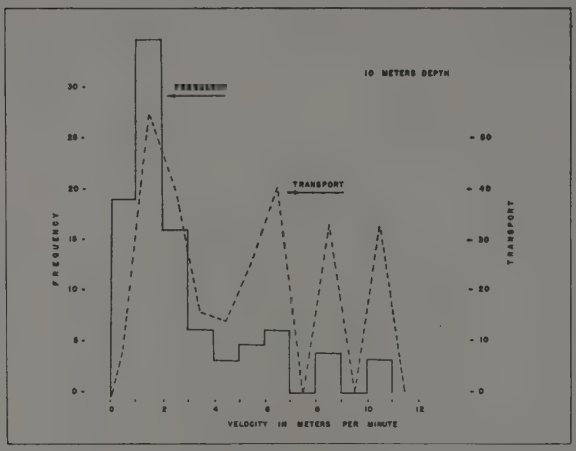

FIGURE 4. Frequency and transport of currents at 10 meters depth, July, 1949. 90 velocity and direction measurements.

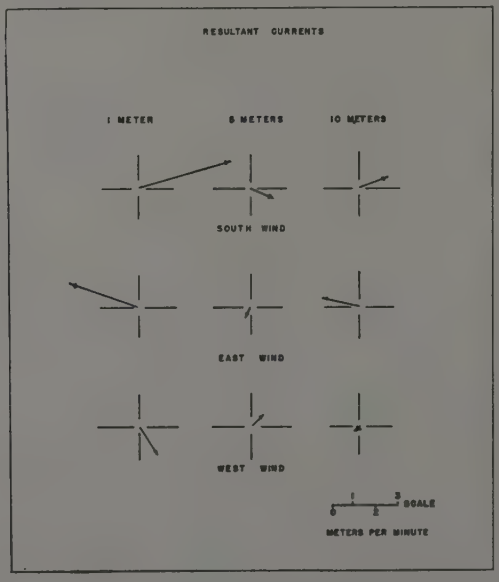

FIGURE 5. Resultant Currents. Over 300 velocity and direction measurements during the summer of 1949.

of the hypolimnion from 1 to 3 meters per minute. However, the strongest current observed, over 33 cm/sec or 20 meters per minute was in the hypolimnion at a depth of 60 feet. This would suggest that the currents of the hypolimnion are produced by direct solenidal circulation while the currents in the epilimnion are wind driven.

The observations are summarized a little differently in figures 2, 3 and 4. An interesting feature of figure 2 is the bimodal distribution of the frequency with which each velocity was observed in the central portion of the lake. From figures 3 and 4 it may be observed that these slower velocities are by far the most frequent. However, while the higher velocities are less frequent, they are very important from the standpoint of water transport. Fifty percent of the transportation of water by surface currents is accomplished by the fastest 28 percent of those currents. The corresponding figure at five meters is 18 percent and at ten meters, 16 percent. Thus, not only do the cases of extreme disturbance associated with high winds strip the upper layer of the thermocline and bring it to the surface, but also accomplish a disproportionate amount of re-distribution in a horizontal sense.

In figure 5 resultant velocities for the central portion of the lake are presented. These are separated according to wind direction and depth. In general, the currents at the surface are a little to the right of the wind direction while those at depth show far less relationship. In considering relation of current velocity to wind velocity the temperature difference between water and air must be taken into account. A south wind is usually warmer than the water and a north or east wind usually colder. The "frictional link" between air and the water is better if the air is cold, hence we should expect a closer agreement in direction between wind and water when the wind is from the north or east and higher current velocities for a given wind speed.

SUMMARY

The results of this study have shown the following: (1) The wind produces wind-driven currents toward the downwind side of the lake, in the epilimnion. (2) The surface currents average about 4 meters per minute, while those of the hypolimnion averaged about 3 meters per minute. (3) The currents of the hypolimnion appear to be produced by direct solenoidal action, and in some cases faster than surface currents. (4) High winds can strip the upper layer of the thermocline and bring it to the surface.

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Elementary Medical Statistics. *Donald Mainland.* W. B. Saunders Company, New York. 1952. ix+327 pp. $5.00.

This book will be useful to students of medicine and to research workers in experimental and clinical medicine, but it will also serve biological experimenters generally.

It covers the traditional topics of an elementary book in statistics, with an aptness of examples and a clarity of explanations that are unsurpassed. Both enumeration and measurement data are considered in dealing with statistics of description and with methods of testing hypotheses. The concept of power of a test is not mentioned; the Poisson distribution is explained only briefly.

E. L. Green.

SOME NEW SPECIES OF PROTALEBRA FROM MEXICO

(HOMOPTERA: CICADELLIDAE)

ROBERT F. RUPPEL AND DWIGHT M. DELONG

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The genus *Protalebra* was erected by Baker (1899) to include the *Alebra*-like species with appendices which do not extend to the apices of the elytra. *Alebra curvilinea* Gillette (1898) was selected at that time as the genotype. Species of the genus have been described subsequent to Baker's paper by Baker (1903), Osborn (1929, 1928), Knull (1940), McAtee (1926), Van Duzee (1907, 1923), DeLong (1923), Dozier (1927), and Oman (1937). protalebra is predominately neotropical in distribution with species of the genus known to occur from Brazil to the southern United States and the islands of the Caribbean.

Our examination of collections of typhlocybine specimens from Mexico has shown seven new species of *Protalebra* which are described below. Unless otherwise stated, the types of these species are in the DeLong collection.

Protalebra variata n. sp.

A large, robust species with a rounded vertex which resembles **omega** VanDuzee except for its color pattern and genital structures. Length 3.3 mm.

Color: The vertex is ivory with a pair of large, round, black spots near its apex. The disk of the pronotum is orange, its anterior margin is yellow, and its posterior margin is broadly bordered with an ivory band. The scutellum is light yellow with its apex black. The elytra are light tan with their apices and transverse veins enbrowned and with a hyaline band extending transversely across the middle of each clavus to the center of the corium. The anterior portions of the apical cells are hyaline, a fine brown line extends from the middle of each costal margin to the apex of each clavus, and a similar line borders the anterior margin of the hyaline band on the clavus. The face and venter are immaculate cream.

Genitalia: The pygofers are long with their apices pointed and with sickle-shaped processes arising on their ventral margins. The plates are long and very slender. The styles are long and slender with their apices curving sharply ventrad. The dorsal processes of the base are slender and pointed at their apices, and the phalicata is slender and long and bears a sharp spine near the base of its ventral margin.

Holotype male collected at Cutzamala, G'ro., Aug. 20, 1930 (MF 1768) by J. Parra; male paratypes Zincauro, G'ro., Sept. 2, 1930 (MF 1789), J. Parra.

Protalebra plummeri n. sp.

Resembling *sanguinolinea* (Baker) in general form and appearance but with a distinctive coloration. Length 2.6 mm.

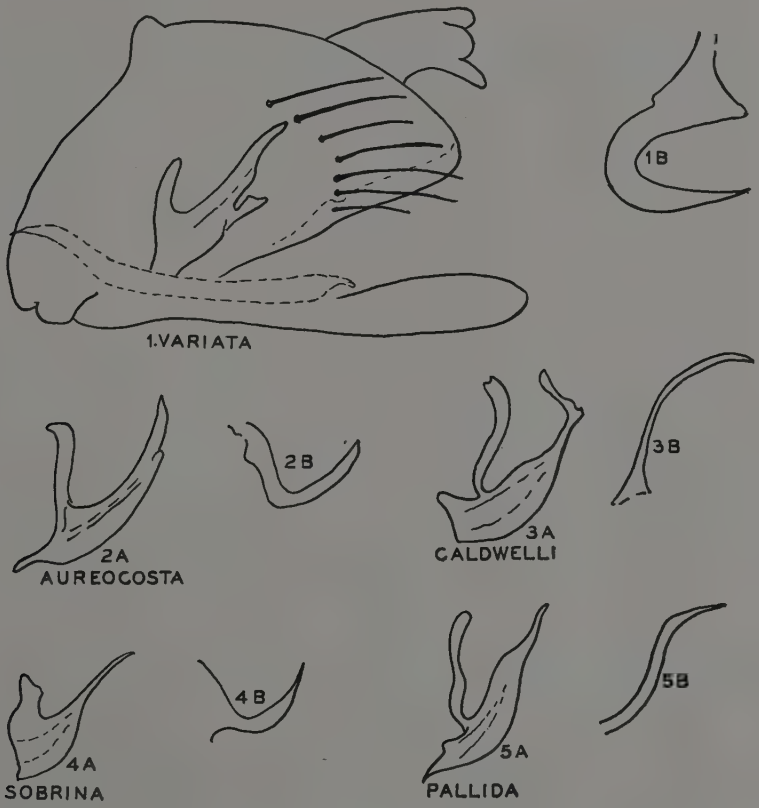
Color: The vertex is an immaculate light cream. The pronotum is ivory with its lateral margins and the anterior portion of its disk red. The scutellum is orange-tan with its basal angles yellow and its apex black. The elytra are translucent white with their apical cells hyaline and enbrowned and with their bases orange-brown edged posteriorly by a fine scalloped brown line. This brown line extends obliquely from the costa to the apex of the clavus and then transversely back to the middle of the costal margin. The centers of the coria are smoky and the disks of the clavi are golden. The sides of the pronotum are red, the face and the venter are ivory with the first two abdominal sternites and the centers of the pygofers and ovipositor black.

Holotype female collected at Chilpancingo, G'ro., Oct. 25, 1941 by DeLong and Good,; paratype female collected by the same collectors at Iguala, G'ro., same date.

Named for Mr. Charles Plummer who has aided in the collection of many of the specimens used in this study.

Protalebra aureocosta n. sp.

Resembling *decorata* (Osborn) in general form and appearance but with distinctive coloration and male genital structures. Length 2.8.mm.



FIGURES 1–5. 1a—*Protalebra variata*—lateral view of genital capsule; 1b—left pygofer process. 2a—*P. aureocosta*—lateral view of aedeagus; 2b—lateral pygofer process. 3a—*P caldwelli*—lateral view of aedeagus; 3b—lateral pygofer process. 4a—*P. sobrina*—lateral view of aedeagus; 4b—lateral pygofer process. 5a—*P. pallida*—lateral view of aedeagus; 5b—lateral pygofer process.

Color: The vertex is ivory with a broad, red line extending across its disk between the eyes. The pronotum is ivory with its lateral margin and the anterior portion of its disk bordered with a broad red band. The scutellum is golden. The elytra are white with three large, anastomosing orange-red spots on each clavus, a pair of similar spots on the disk of each corium, and an elongate golden spot on the proximal third and middle of each costal margin. The face is golden with the genae and lorae ivory, the venter is ivory to cream.

Genitalia: Male genitalia similar to those of *decorata* but the processes of the pygofers are slender, rather short, and extended ventrad to near their centers where they bend abruptly dorsocaudad.

Holotype male collected at Iguala, G'ro., Sept. 11, 1939, by D. M. DeLong; paratypes collected at, Iguala and Chilpancingo, G'ro., Oct. 25, 1941, and Taxco, G'ro., Oct. 26, 1941, by DeLong and Good; paratype Jintepec, Mor., Sept. 6, 1939, by DeLong and Plummer.

Protalebra caldwelli n. sp.

A beautifully colored species which resembles *decrata* (Osborn) in general form but which has distinctive genitalia and strikingly different coloration. Length 3.0 mm.

Color: The vertex, pronotum, and scutellum are ivory, immaculate. The elytra are translucent shaded with gold on the disk of the coria and clavi and with a large orange spot and a brown band on the transverse veins.

Genitalia: The genital capsule is similar to that of *decorata* except that the pygofer processes are much longer, more slender, and straighter. The dorsal processes of the aedeagus appear clavate and the phalicata bears a thin, elongate spine at its apex.

Holotype male collected at Santa Engracia, Mex., Nov. 11, 1938 by J. S. Caldwell; male paratypes collected at Tamazunchale, S.L.P., Dec., 23, 1949 by R. H. Beamer. The paratypes are deposited in the Snow Museum.

Protalebra sobrina n. sp.

A somber colored species which resembles *decorata* (Osborn) in general form but which has distinctive coloration and genitalia. Length 3.0 mm.

Color: The vertex is light yellow with a median and a pair of longitudinal short, brown lines on the posterior margin of its disk; these lines fusing on the posterior margin. The pronotum and scutellum are brown. The elytra are brown with their costal margins broadly bordered with yellow and with a few hyaline areoles scattered across them. The face and venter are immaculate cream.

Genitalia: The pygofers of the male are very slender, their ventral margin is strongly rolled inward, and their thin processes arise on the ventral margin and are abruptly bent near their middles. The styles are rather short with their first extensions short and curving laterad. The aedeagus has its dorsal processes erect and its phalicata slender and tapering to a sharp apex.

Holotype male and male paratypes collected at Iguala, G'ro., Sept. 11, 1939 by D. M. DeLong; male paratype same locality, Oct. 25, 1941 by DeLong and Good.

Protalebra pallida n. sp.

A palled species which resembles *sobrina* in general form but which has a rounded head and unique coloration and genitalia. Length 2.8 mm.

The head is distinctly narrower than pronotum produced for about one-half of its length in front of the eyes, and with its forward margins rounded.

Color: The dorsum is golden-yellow marked with but a round, brown spot in the base of the third apical cell of each elytron. The face is ivory white the venter is immaculate cream.

Genitalia: The male genital structures are similar to those of *sobrina* but the pygofer processes are long, slender, and slightly recurved. The phalicata is very slender and sharply-pointed.

Holotype male collected at Iguala, G'ro., Sept. 11, 1939 by D. M. DeLong.

Protalebra conica n. sp.

Resembling *braziliensis* Baker in general form and appearance but with a more angulate vertex and a distinctive coloration. Length 3.2 mm.

Vertex conically produced, bluntly angulate at its apex, its median length equal to its basal width.

The coloration is similar to that of *braziliensis* but the vertex has a pair of short, median, brown lines near its apex, and the hyaline areoles on the elytra are much larger.

Holotype female and paratype females from El Naranjo, S. L. P., Jan. 2, 1950, paratype female Tamazunchale, S.L.P., Dec. 23, 1949, all collected by R. H. Beamer. Types in the Snow collection.

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A Hundred Years of Biology. *Ben Dawes.* Gerald Duckworth & Co., Ltd., London, and Macmillan Company, New York. 1952. 429 pp. $5.00.

The modern era of biology opened about the time of Darwin's *Origin of the Species*, and this book deals with subsequent biological advances. The author's aims are "to provide a readable picture of those matters which relate to living organisms by sketching a historical background and the main trends of biological development" and "to show the specialist student where he can find much more information" than can be included in this one volume of the *Hundred Years Series*.

An outline of the historical framework of biology is followed by a discussion of mechanical devices and techniques, including microscopy, slide preparation, tissue culture and cinematography, which facilitate biological study. The rise of such fields of investigation as vitamins, hormones and cytochrome is traced as is that of evolution and genetics.

In "protoplasm and cell" emphasis is placed on description of protoplasm, cell divisions and the role of nucleic acid in cellular activity.

Reproduction, development and growth of animals are each discussed in separate chapters. In the preface the author states that botanists are likely to be disappointed because of the lack of consideration of plants, and in these three chapters the omission is particularly obvious.

Genetics principles and some common types of inheritance in plants and animals are carefully described and applied to agriculture and to human inheritance.

In dealing with taxonomy, Dr. Dawes stresses application of taxonomy to cytology, ecology, genetics and evolution.

The properties and activities of chlorophyll, haemoglobin and cytochrome are surveyed in chapter ten along with some functional problems concerning feeding mechanisms, digestive processes and glomerular action.

Animal receptors are mentioned and their action is outlined in accounts of pseudopodial, ciliar, flagellar and muscular contractions. The similarity between action of cilia and cardiac muscle stressed.

In discussing nervous systems and coordination, chromatic response is particularly considered, with animal behavior interpreted on the basis of various types of orientation, chain-like patterns, holistic responses and learning by experience.

Some special fields are given more detailed discussion by having separate chapters devoted to each—evolution, parasitology, marine biology, antibiotics and agricultural biology. The three latter deal almost exclusively with research in and concerning Great Britain. Some readers may find this irksome, but its value from a cultural point of view and biological significance is readily seen. In the last chapter of the book certain British research institutes and their work are described. Finally some 33 pages are devoted to a most excellent listing of pertinent literature.

This is a fine reference book in which Dr. Dawes presents in an interesting manner much valuable material for both the general and the specialist student.

E. Eloise Whitwer.

RELATIONSHIP OF *SPHAERIUM SOLIDULUM* PRIME TO ORGANIC POLLUTION

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This investigation was prompted by varied statements in the literature concerning the relationship of the Sphaeriidae of the genera *Sphaerium*, *Musculium*, and *Pisidium* as they may or may not be related to organic pollution, by a desire of the writers to suggest quantitative methods for the collection of bottom organisms in a small creek and for a valid expression of numbers of benthonic organisms.

The field work was carried out on Lytle Creek (with a c. f. s. of approximately 0.55 to 7.0), in the vicinity of Wilmington, Ohio. The source of organic pollution in Lytle Creek is domestic sewage from Wilmington with a population (1950 census of population, preliminary counts) of 7,412. Wilmington is sewered and has primary sewage treatment facilities. This treatment is not enough, however, to prevent septicity from setting in in the stream during periods of low flow. Stream surveys made in August, September, and October of 1950 showed that septicity extended from the sewage treatment plant outfall to approximately one mile downstream.

Data included here were collected by the writers sporadically from March 1950 through June 1951 in association with a field reseach problem by the Biology Section of the Environmental Health Center. The chemical and bacteriological data are presented to show generally the possible characteristics of a stream at certain stations; such data were gathered during August 15–18, 1950.

Lytle Creek at the time these studies were made was relatively free from wastes other than treated sanitary sewage.

The Sphaeriid that the writers deal with in this paper is *Sphaerium solidulum* Prime. Collections of this finger-nail clam made during 1950 and 1951 indicate that its distribution in Lytle Creek in relation to organic pollution is static and does not vary as chemical and bacteriological data quite naturally do.

CHEMICAL AND BACTERIOLOGICAL DATA

Complete chemical data are not available for each clam collecting station. They are presented here to show the general chemical and bacteriological characteristics of certain stations at static times; for example, chemical data are presented for control station 8. 7, sewage plant outfall, and point of mixing of effluent and stream.[2] The chemical data in each instance represents the average of 12 composite samples taken every two hours for three 24 hour periods between August 15-18, 1950.

Control station 8.7 is unpolluted except for drainage from farm lands. Chemical and bacteriological data are: pH, 7.9; M. O. alkalinity, 219 p.p.m.; chloride, 0.12 p.p.m.; total nitrogen, 6.59 p.p.m.; NH_3-N, 0.2 p.p.m.; NO_2-N, 0.016 p.p.m.; NO_3-N, 0.16 p.p.m.; total PO_4, 0.55 p.p.m.; soluble PO_4, 0.15 p.p.m.; 5 day B. O. D., 1.71 p.p.m.

[1]Respectively: Biologist, Ohio-Tennessee Drainage Basins Office, Division of Water Pollution Control, Public Health Service; Training Instructor (Sanitary Training) Specialized Sanitation Training Section; Biologist, Biology Section, Environmental Health Center, Public Health Service.

[2]Station figures cited here, i.e., 8.7, represent miles and tenths of miles above the mouth of Lytle Creek.

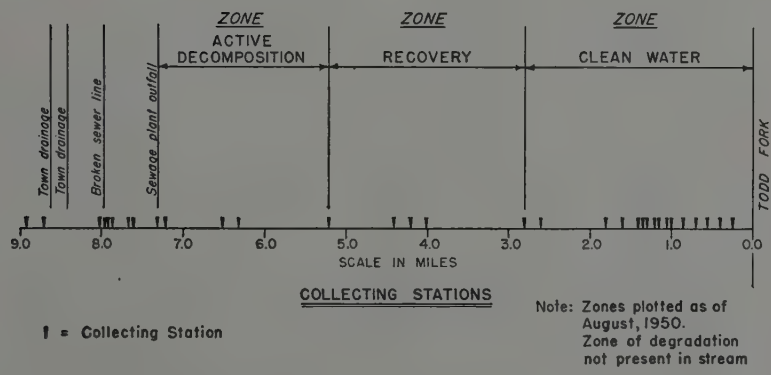
The sewage treatment plant effluent showed the following data: pH, 7.0; M. O. alkalinity, 253 p.p.m.; chloride, 39.0 p.p.m.; total nitrogen, 35.0 p.p.m.; NH_3–N, 23.5 p.p.m.; NO_2–N, < 0.002 p.p.m.; NO_3–N, 0.14 p.p.m.; total PO_4, 15.0 p.p.m.; soluble PO_4, 10 p.p.m.; 5-day B. O. D., 159 p.p.m.

The point of mixing of the sewage treatment plant effluent and stream showed: pH, 7.1; M.O. alkalinity, 235 p.p.m.; chloride, 41 p.p.m.; total nitrogen, 28.7 p.p.m.; NH_3–N, 18.5 p.p.m.; NO_2–N, < 0.002 p.p.m.; NO_3–N, 0.14 p.p.m.; total PO_4, 12.0 p.p.m.; soluble PO_4, 8.0 p.p.m.; 5 day B.O.D., 124 p.p.m.

Data for bacteria of the coliform group for two stations showed a M. P. N. per 100 ml. of < 100 at station 8.7 and a M. P. N. per 100 ml. of 30 million at the point of mixing of the effluent and the stream.

Stream flow at a gaging station below the sewage treatment plant effluent indicated that during the period that the above chemical and bacteriological data were gathered the flow was approximately 0.55 c f s. Ninety-four percent of the flow in Lytle Creek below the sewage treatment plant at the time data were gathered consisted of the sewage plant effluent.

POLLUTION ZONES—LYTLE CREEK
REFERENCED TO
SPHAERIUM COLLECTING STATIONS



DISCUSSION OF LITERATURE

As indicated by selected references relative to pollution as cited below, data on the Shaeriidae are quite qualitative, sometimes having been compiled without exact cognizance of the pollutant or of the specific relationship of these clams to the pollutant. Statements that indicate that the Sphaeriidae as a group are tolerant to water fouled by domestic sewage do not always appear to be valid when related to the findings of the writers. Instead it appears that the Sphaeriidae should be identified to species as certain ones may or may not relate to pollution from domestic sewage.

Suter and Moore (1922) state in reference to *Pisidium abditum* Hald. for New York State, ". . . a mollusk which attaches itself to plants carrying sludge accumulations. Thrives in waters polluted by domestic sewage." Richardson (1928) in his work on the Middle Illinois River states in reference to *Musculium*

transversum (Say), "No index value; equally common in some situations on clean bottom, and believed to be a case of recent adaptation." This writer in the same paper in tabulation of the tolerance of various organisms to "pollution" lists *Pisidium compressum* Prime, *Musculium transversum* (Say), and *M. truncatum* (Linsley) in his "Subpollutional, unusually tolerant; common to abundant at some stations in the pollutional, zone; but with original natural preference for the subpollutional or cleaner water zones." Richardson (1928) lists *Pisidium pauperculum* var. *crystalense* Sterki, *P. complanatum* Sterki, *S. striatinum* var *lilycashense* F. C. Baker and *S. stamineum* (Conrad) in his "Subpollutional, less tolerant, more common species; normally preferring clean water; but able stand subpollutional conditions even where current is slight."

Morgan (1930) makes the following general comment relating to the type of bottom and type of water with which the Sphaeriidae may be associated. "They are widely distributed, almost sure to be found in any kind of fresh water. They live on bottoms of sand and mud or clay and often creep up over plant stems." Carpenter (1928) writes in relating *Sphaerium* to organic pollution, "Passing away from the source of pollution, recovery sets in, owing to removal of organic matter by decomposition and digestion, and absorption of oxygen from the atmosphere. In this phase detritus feeders are dominant: particularly high numbers are attained by Protozoa in great variety, especially Ciliates and Flagellates, Oligochaets, and Nematodes; to these are soon added small Lamellibranchs (especially *Sphaerium*), Limnaea, and many Diptera surface-breathing larvae (as *Ptychoptera, Psychoda, Stratiomys*, [*Stratiomyia*] *Culicidae*). . . . . ."

Baker (1922), working in Illinois, presents the following data on the relation of the Sphaeriidae to pollution: "The distribution of the *Sphaeriidae*. . . is interesting and significant in connection with the sewage pollution of the stream . . . no *Sphaeriidae* were found. . . between the Urbana ditch and . . . 14 miles below Urbana. These mussels are characteristic mud dwellers, and their absence from the intervening territory in the stream is striking evidence of the unfavorable conditions on the bottom."

Purdy (1930) in discussing the Sphaeriidae and pollution in his bulletin on the Illinois River states, "These small mussels are often very numerous in water which is moderately polluted; thus they are often to be found with Tubificidae. However, they cannot stand the extreme conditions that the worms can; hence will die out when oxygen becomes largely depleted. Apparently their large numbers in places where water is polluted is a question of their abundant food supply of microscopic organisms normally found there." Kehr, Purdy, et al. (1941) state in their bulletin on the Scioto River where reference is made to Purdy's (1930) paper, "Sediments from the upper sewage-polluted sections of the river had a strong, unpleasant odor. Organisms in these sediments consist chiefly of tubificid worms, which were very numerous averaging over 2,000 per liter of mud. Certain sewage-tolerant urganisms (*Sphaeriidae* and larvae of *Chironomids*) were moderately abundant. Such forms as are normally found in the odorless sediments of cleaner streams populated by fish were practically absent." Ellis (1937)writes the following on the *Sphaeriidae* in relation to organic pollution, "Studies of the bottom faunae of polluted streams, particularly those carrying quantities of organic pollution, have shown that many of the bottom species of unpolluted streams are sensitive to pollution conditions, so that as pollution progresses the normal fauna changes giving way to certain more tolerant species of tubificid worms, chironomid midges, spaeriid mollusks, and leeches." It is not the point of this paper to discuss extensively animal relationships in Lytle Creek, however, the writers but rarely found Tubificid worms associated with *Sphaerium solidulum* Prime. Gaufin and Tarzwell (1952) in their paper on Lytle Creek, Wilmington, Ohio, observed that *Sphaerium solidulum* Prime was not associated with water polluted by domestic sewage.

METHODS OF SAMPLING AND EXPRESSION OF ABUNDANCE

Sampling was carried out entirely by using an Ekman dredge 6 x 6 inches square. The dredge was adapted for shallow water sampling (by Dr. C. M. Tarzwell. Chief, Biology Section, Environmental Health Center) by riveting an iron pipe over the trigger mechanism, thus a messenger could be dropped through the pipe-handle to trip the trigger and close the dredge. The handle, thus riveted, functions as a stabilizer ensuring one of an exact position over a selected bottom area.

Through use of the messenger the same force is applied always to the grab of each sample, given a similar bottom stratigraphy. It was found by the writers that on the bottom preferred by *Sphaerium* the Ekman grab collected a fairly uniform one and one-half inches of sediment.

To determine a bottom stratigraphy where one could be assured of finding clams if they were at all present twenty exploratory Ekman hauls were made. A coarse sandy bottom is a typical substrate in Lytle Creek for *Sphaerium solidulum;* they are not found in fine silt deposits nor on shaley riffle areas where sand is lacking. They are not associated with sludge beds.

Here abundance of clams is expressed as the number of clams taken per five Ekman hauls that were taken as a representative sample at each station. The expression of the number of clams per acre or even per square foot of bottom based on single Ekman hauls at fixed stations would make numbers purely qualitative in a stream the size of Lytle Creek and with its varied bottom stratigraphy. This, therefore, was not done. In stream surveys, the writers feel strongly that numbers of individuals should be expressed in terms of collecting device employed, *i.e.*, Ekman, Petersen, Surber, thus number-of-individual figures become significant in relation to a fixed dimension that is a standard in the operators hands. Varied personal elements were removed from the actual collecting of samples in that the writers worked closely together on each Ekman haul, thus excluding variation that well could have taken place if hauls had been made by four collectors, each working alone.

DISTRIBUTION OF CLAMS

To determine the distribution of clams along some 9.0 miles of Lytle Creek, 180 Ekman hauls were made (table 1). These showed that clams reached their maximum abundance, eighty-five in 5 Ekman hauls, at station 8.7, the control station removed from pollution by domestic sewage. At station 8.9, an upstream check point used to determine the leveling off of clam abundance, 82 individuals were taken in 5 Ekman hauls, thus it was established that a near plateau existed between the "clean" water station 8.7 and check point 8.9 in clam populations, 85 *vs.* 82. Clam populations steadily dropped to station 8.0 where 37 were taken in in 5 Ekman hauls. Between stations 8.7 and 8.0 there existed 2 points where town drainage entered into Lytle Creek. Chemical and bacteriological data are not available at these points; however, it was observed by the writers that oily wastes were often present entering the stream from these drainage points, perhaps in sufficient quantities to affect clam abundance adversely in reducing food organisms.

At station 8.0 a broken sewer pipe allowed a trickle of sewage to enter the stream. This had no adverse effect on clam populations; to the contrary the clam populations increased just below the broken sewer pipe from 37 in 5 Ekman hauls at station 8.0 to 62 in 5 Ekman hauls 50 yards downstream, possibly reflecting the effect of non-injurious fertilization and indicating that the oily wastes that were entering Lytle Creek upstream from station 8.0 were not affecting the clam populations here. At station 7.9 populations dropped to 43 in 5 Ekman hauls, then increased slighty to 47 in 5 hauls at station 7.7, decreasing to 40 in 5 hauls at station 7.6, to fall sharply to 0 in 5 hauls at station 7.3, the sewage treatment plant outfall.

Associates of *Sphaerium solidulum* in the above stretch of stream were limited to a few forms which display special adaptations to enable them to live in or on the sandy bottom inhabited by this mollusk. These were nymphs of the mayfly, *Caenis;* dragonfly, *Libellula;* and larvae of the alderfly, *Sialis*. However, these forms, unlike *Sphaerium*, were also present in the clean water zone downstream from the zone of recovery.

From station 7.3 to station 0, where Lytle Creek joins Todds Fork, no clams were found. From station 7.3 to station 0, five Ekman hauls, all showing 0 results, were made at each of the following intermediate stations: 7.2, 6.5, 6.3, 5.2, 4.4, 4.2, 4, 2.8, 2.4, 2.0, 1.8. 1.6, 1.55, 1.50, 1.40, 1.3, 1.0, 0.85, 0.7, 0.55, 0.4, 0.25, and zero.

The disappearance of clams at 7.3 can be explained by low D. O. conditions setting in at this station where on occasion septicity immediately develops and holds through station 6.5. From station 6.5 through station 5.2, about the beginning of the zone of recovery, there is no especially obvious reason why clams should not re-appear except for the substratum being heavily coated with zoogleal organisms which could conceivably cut off their food and possibly even the oxygen supply, since zoogleal organisms would rest over the clams buried in the substrate. From station 5.2 through station 0 there are extensive areas of bottom that could be considered typical for clam abundance, however, claims remain absent.

An explanation for the absence of clams from station 5.2 to 0 is difficult. Any explanation offered can be only highly speculative. The writers first considered that the clam might be a headwaters species. To check this hypothesis, sampling was done on another creek, Cowan Creek, in the general vicinity of Wilmington, Ohio. Cowan Creek is bedded over similar geological strata and has typical clam bottom situations similar to Lytle Creek. Collections of clams on Cowan Creek dispelled the thought that we were dealing with a headwaters clam for they extended well downstream through the relative geologically mature stream bed.

It is conceivable that the flush-outs of Lytle Creek which occur below the sewage treatment plant, carry enough fine sediment from sludge areas in the stream below the outfall to prevent a clam population from becoming established in its lower reaches. The smothering effects of such sediment as it settles out could directly destroy clams. Some evidence is available for this hypothesis from whitened, dead clam shells that were taken in place in the basically sandy stream bottom at station 5.2.

It is further conceivable that with the flushing out of Lytle Creek along its course from month to month, that clams, washed down from upstream areas, could not successfully seed the mature stream bed and produce a growing thriving population. Thus as clams are washed downstream, from immature stream bed areas, many are lost on sand bars where they settle as the water subsides. Dead shells in such areas attest to this hypothesis.

CONCLUSIONS

The writers do feel that this general study does present the following pertinent data.

1. *Sphaerium solidulum* may respond to a slight fertilization effect from domestic sewage by increased productivity.
2. *Sphaerium solidulum* cannot live under conditions of septicity.
3. Silting effects populations of *Sphaerium* in the area studied, clams not being found on silt bottom in downstream areas below sludge deposits.
4. *Sphaerium* is not found where gelatinous zoogleal organisms cover typical *Sphaerium* bottom areas.
5. *Sphaerium solidulum* is not a headwaters species locally.
6. Numerical results of Ekman dredge samples in order to establish a quantitative expression which can be set as a standard, should be recorded in number per dredge haul, or in total numbers per total dredge hauls. An equal number

of Ekman hauls should be taken at each established collecting station.

7. Preparatory to conducting a stream survey for benthonic organisms with an Ekman dredge as a campler, as for example, a *Sphaeriid* survey, exploratory hauls should be made to determine if organisms are especially occupying but one type of bottom, i. e., sand or silt. From such preliminary sampling the collector can establish a fairly typical bottom to collect in from station to station.

8. Statements in the literature that indicate that the Sphaeriidae as a group are tolerant to water fouled by domestic sewage do not always appear to be valid. These clams should be identified to species as certain ones apparently may or may not tolerant intensive pollution from domestic sewage.

9. Under the conditions and period of time stated in this paper *Sphaerium solidulum* Prime was not tolerant of intensive pollution from domestic sewage. Thus, this clam proved to be a negative indicator organism.

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Fleas, Flukes and Cuckoos. *Miriam Rothschild and Theresa Clay.* Philosophical Library, Inc., New York. 1952. xiv+304 pp. $8.75.

Some years ago A. E. Shipley wrote, "Birds are not only birds but aviating zoological gardens" and Rothschild and Clay present an abundance of information on this subject as indicated by their chapter titles which are: Parasitism, Commensalism, Symbiosis, The effect of parasites on the host, The effect of parasitism on the parasite, The origins of parasitism and the evolution of parasites, Fleas, Feather lice, Protozoa, Worms, Flies, Mites, Micro-parasites, The fauna of birds' nests, Skuas, and The European cuckoo. Also there is an excellent bibliographical appendix and a general index. The 40 plates and additional figures are very good and add much to the book.

In addition to being a scholarly treatise on bird parasites this fascinating book serves as a delightfully written introduction to the science of parasitology from the biological rather than from the usual medical or veterinary aspect. Therefore, there is much of value to both the serious student and the amateur naturalist.

The authors are prominent British zoologists and in the United States are best known for their researches on bird fleas and bird lice. Their volume is one of a series, published as the New Naturalist Library, which has over thirty titles finished or in preparation.

CARL VENARD.

FACTORS AFFECTING THE ECONOMICS OF SOIL CONSERVATION

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Economic returns from conservation farming are influenced by many factors. Some are associated with the direct application of recommended practices. Others are associated with changes that occur in farm organization as a result of adopting conservation rotations. The purpose of this discussion is to consider how costs and returns from conservation practices depend upon (1) different levels of conservation, (2) soil type, (3) crop disposition, (4) price relationships, and (5) period of time considered.

COMPARISON OF DIFFERENT LEVELS OF CONSERVATION

Returns from soil conservation practices depend upon the comparative levels because many degrees of intensity exist in actual practice. Different levels are possible in many areas because of the number of practices recommended. For example, some farmers follow a good rotation, but fail to adopt the mechanical practices recommended for their farms. Other farmers apply an adequate amount of lime and fertilizer on the cropland, but continue to follow a soil depleting rotation. In other cases, farmers lime and fertilize the cropland, but the amounts applied are lower than recommended applications.

Since most farmers follow some soil conservation recommendations, farms cannot be divided into conservation and non-conservation groups for purposes of analysis. A certain amount of soil conservation is accomplished whenever a farmer applies lime or fertilizer, or raises a meadow crop. However, many farmers may not be following adequate soil conservation practices to maintain their farms as producing units. Greatest returns from conservation farming should occur when comparisons are made between low and high levels. Smaller returns might result when comparisons are made between medium and high levels. Costs and benefits might still be different when comparisons are made between low and medium levels.

In calculating potential returns from adopting conservation practices, comparisons must be made with some ideal program. Potential returns for a specific farm will depend upon the objectives to be accomplished. For example, conservation farming might be based purely upon physical objectives. In this case, the goal might be to increase the productivity of the soil and maintain it near the original level. In rough areas, this objective may require using the land only for permanent pasture or woods. In level areas, rotations with a high percentage of meadow crops may be necessary to more nearly meet this goal. Other conservation objectives might be based upon economic considerations. In this case, the goal would be to apply conservation measures as long as the additional costs did not exceed the additional returns. Costs and returns from soil conservation practices might be calculated from the standpoint of the individual farmer or society. In some cases, these calculations may not coincide inasmuch as different periods of time are considered. Many farmers are interested only in economic benefits for the period they plan to operate the farm, but society must be concerned for a much longer period of time. Different conservation objectives will require different expenditures of labor and capital for establishment and maintenance. Returns also will vary according to the amount of conservation practices applied. Therefore, the economics of conservation farming will depend upon the goals to be achieved and the levels compared.

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SOIL TYPE

Economic benefits from adopting needed conservation practices will vary according to soil type. Some soils may be depleted of their productivity and brought back without any permanent damage. In this case, costs of soil depletion are actually the costs of restoring the productivity to a previous level. In addition to these temporary losses, other costs must be considered when permanent damage occurs from erosion. These costs will vary according to soil type and amount of erosion that has occurred. The economics of soil conservation is affected also by the rate of soil erosion and fertility depletion. Some soils may be depleted to unprofitable levels in a shorter period of time than others.

Costs of establishing soil conservation practices will vary according to soil type and topography. These expenses are often small in level areas where recommendations include only conservation rotations supplemented by adequate amounts of lime and fertilizer. Where drainage is needed expenses are considerably higher, the amount depending upon whether complete or random tiling systems are established. In rolling areas where erosion is serious, expenditures are often made to establish mechanical as well as agronomic practices. When terraces are established, costs are increased at the time they are constructed. Field arrangement may be improved on some farms by fencing on the contour. On other farms, additional lanes and watering facilities may be needed for livestock because new fields do not connect with the barnlot. Contour cultivation may produce longer rows on some farms, but on others point and crooked rows may interfere with the use of modern farm machinery.

In areas where the land is too irregular to apply mechanical practices, conservation recommendations usually include less grain and more meadow crops in the rotation. This often results in additional expenditures for livestock and buildings to utilize more hay and pasture. The kind of hay raised is often influenced by the type of soil. On some soils legume hay is difficult to raise in second and third year meadows because alfalfa winterkills. In this case, high quality hay is not available to offset reductions in grain acreage.

DISPOSITION OF CROPS

Returns from adopting conservation rotations will depend upon the disposition of crops raised. For most soils, some meadow crops are needed in the rotation for maximum grain production. Under certain conditions, raising more meadow crops not only increases forage production, but also total grain production. This relationship exists as long as reductions in the acreage of grain are offset by sufficient increases in the yields per acre. Meadow crops increase grain yields by improving soil structure, adding nitrogen and controlling erosion. As long as total grain production increases when more meadows are raised, additional forage presents no problem. In this case hay can be turned under and income will still be higher than it would be if less acres of hay were raised. This is due to the fact that a reduction in the acreage of meadows would decrease the production of both grain and forage.

As more acreage of meadows is added to the rotation, a point is reached where total production of grain declines. This occurs whenever yields per acre fail to increase fast enough to offset reductions in grain acreage. When total grain production declines as a result of adding more hay crops in the rotation, net receipts also will decline unless some income is obtained from forage crops. Under certain conditions, income per acre from hay may be less than the income from grain. Hay is often more difficult to sell than grain because of variation in quality. Unfavorable weather during the harvesting season will reduce the quality of hay more than corn. In wet seasons farmers may lose a whole cutting of hay, but they seldom lose a crop of corn. In some areas, the price of hay varies considerably

more than the price of grain. On some farms more hired labor is needed to harvest hay than grain.

When forage is fed to livestock, farm income will depend upon the type and efficiency of the livestock kept, and the price of livestock and its products. In many cases the dairy farmer will find it much easier to adopt conservation rotations than the hog farmer. Dairy farmers can use large quantities of hay and pasture, but hog farmers want only enough meadow crops to maintain corn yields at a profitable level. Some farmers object to keeping dairy cows because they do not want to work seven days a week. Others object to buying feeder cattle to consume additional roughage because of the risk involved. Potenial returns from conservation rotations will vary according to the livestock and marketing programs found on various farms. Returns from rotations with more meadow crops will be low if large amounts of hay and pasture are fed to inefficient livestock. On the other hand, additional meadow crops may increase net farm income on some farms when fed to high producing animals. Returns from feeding more forage to dairy cows will be less in areas where the price of milk is low, and more in areas where the price is higher.

PRICE RELATIONSHIPS

Economic returns from recommended conservation practices depend upon price relationships. Whenever price relationships change, new calculations are necessary to determine the amount of conservation measures a farmer can afford to follow. For example, if the cost of lime, fertilizer or tiling increases in relation to other farm costs, profits will be maximized or greatest by using less of these factors of production. Likewise, if costs of these three factors decline relative to other expenses, profits will be maximized by using more of these factors and less of others. On some farms the amount of grain and meadow crops that will give maximum profits will depend upon the price relationship between hogs and milk. If the price of hogs should increase relative to milk, profits may be made greater by raising more grain and less hay provided enough meadow crops are kept in the rotation to maintain grain yields at a profitable level. If the price of milk should increase relative to that of hogs, profits might be maximized by raising more meadow crops than actually needed for conservation purposes.

Returns from conservation farming will vary according to price relationships. Prices of farm products and costs of production for specific years may vary considerably from the average over a period of time. In some cases, profits might be maximized by raising more grain when prices are high and less when prices are low. Theoretically, this procedure would be sound as long as no permanent damage was done to the soil. However, it might be more practical to follow a good conservation program each year because future prices are difficult to determine accurately.

SHORT TIME VS. LONG TIME RETURNS

The economics of soil conservation depends upon the period of time considered. Net income will increase on many farms after sufficient time has elasped to recover the costs of conservation practices and changes in farm organization. However, during the transition period net income may actually decline for several years because expenses increase more than reciepts. For example, costs of liming cropland are not recovered on many farms until a meadow crop can be produced and marketed through livestock. Similar situations exist when expenditures are made for liming and fertilizing permanent pastures.

Higher crop yields from conservation rotations cannot be expected until better meadow crops are raised and larger residues plowed under. In the meantime total grain production may decline considerably during the transition period because of reductions in grain acreage. Several years may be required before

economic gains from terracing equal cost of construction. Fencing woods against livestock and planting trees will have little effect on increasing immediate farm income. Concrete structures may greatly increase cash outlays the year they are made. Expenditures for housing additional livestock cannot be recovered as quickly when new buildings are constructed as they can when present ones need only minor changes.

Economic benefits from soil conservation practices will vary according to the rate of application. Some farmers adopt all needed conservation measures in a few years. Others use a longer period of time. The rate at which some farmers apply conservation recommendations depends upon their financial resources. At certain times farmers may not have enough available cash to educate their children, modernize the home, make payments on the farm and apply needed conservation practices. In this case, some farmers may prefer to educate their children and modernize their homes at the expense of the soil even though a smaller income results later from this procedure. To some farmers heavily in debt, losses in soil productivity are not as serious as losing the whole farm by foreclosure in the near future.

Many farmers apply conservation recommendations to the point where they think income will be maximized as long as they are interested in the farm. If they plan to retire or sell the farm soon, they often apply only those practices that will pay off in a relatively short period of time. Many tenants are not interested in making expenditures for conservation farming because they have no assurance they will remain on the farm long enough to recover their additional costs.

SUMMARY

1. Many factors influence the economics of soil conservation.

2. Costs and returns are influenced directly by such practices as liming, fertilizing, terracing and drainage.

3. Costs and benefits are influenced indirectly when changes are made in buildings and livestock to utilize more hay and pasture.

4. Inefficient livestock and poor markets for hay and milk reduce potential gains from soil conservation rotations on some farms.

5. Economic returns from soil conservation programs depend upon the period of time considered. During the transition period, net income may decline because certain expenditures are not completely recovered for several years.

6. On some farms, the benefits from conservation farming will depend upon whether the goal is based purely on physical or economic considerations.

7. Since the economics of conservation farming depends upon many factors, most farmers are interested in knowing how these factors influence the amount of conservation practices they can afford to adopt on their farms.

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A VOLUMETER FOR RESPIRATION OF AQUATIC ANIMALS[1]

THOMAS B. CALHOON[2] AND CLIFFORD A. ANGERER
Department of Physiology, The Ohio State University, Columbus 10

The methods for measurement of respiration of small aquatic animals are rather limited. The Wrinkler titrimetric method (Birge and Juday, 1911; Allee and Oesting, 1934) has proved not only laborious but also time-consuming for long-term routine determinations. The respirometric method described here has many advantages over it: (1) continuous oxygen consumption determinations can be made for several hours without disturbing the experimental animals, (2) the respirometric technique involving less manipulations is accordingly subject to less experimental error, (3) the technique gives more linear rates of oxygen consumptions than does the Wrinkler technique, especially when these rates are of low order (fig. 2).

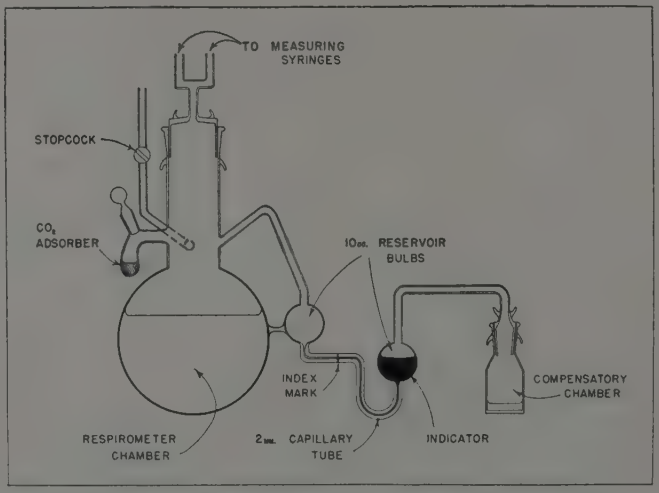

FIGURE 1. The volumeter used for respirometric studies (see text for discussion).

The method to be described here (Calhoon and Angerer, 1949) is based on the same general principle as that employed by Peiss and Vennesland (1949) and Vennesland (1951). It consists in making determinations of volume changes for a closed system maintained at constant pressure. Any decrease in gaseous pressure (oxygen consumed) is compensated by a decrease in total volume. The decrease in volume is measured by an appropriate movement of pistons having known displacements.

The main flask, the respiratory chamber (fig. 1), is of *ca* 500 cc capacity and contains the animal whose oxygen consumption is to be determined. When a

[1]This investigation was supported by a grant-in-aid from the Comly-Coleman Research Fund, College of Medicine, and from the Graduate School, The Ohio State University.

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fish is placed in the chamber, 300 to 400 cc of water are added; when a frog, 25 to 30 cc; and when a small terrestrial animal, no water is required. The upper wall of the respiratory chamber converges to form a neck which is closed by a ground-glass stopper held in place by means of helical springs. Through the neck of the chamber, the animal is placed into the respirometer. From the neck of this chamber emerge 3 side-arms: one wide-mouth arm contains the CO_2 absorber (10% KOH solution); a second side-arm is a vent with stopcock for changing the gaseous armosphere within the respiratory chamber; a third side-arm consists of a 4 mm glass tube which connects to a 10 cc reservoir bulb. On the lower surface of this bulb is attached a 2 mm capillary tube which leads to another 10 cc reservoir bulb connected, in turn, to a compensatory flask. The capillary tube has an index mark etched on it. The compensatory flask contains a few cc of water to assure equal vapor pressure in both the respiratory and compensatory chambers when at the temperature of the water bath. The sensitivity of the system is

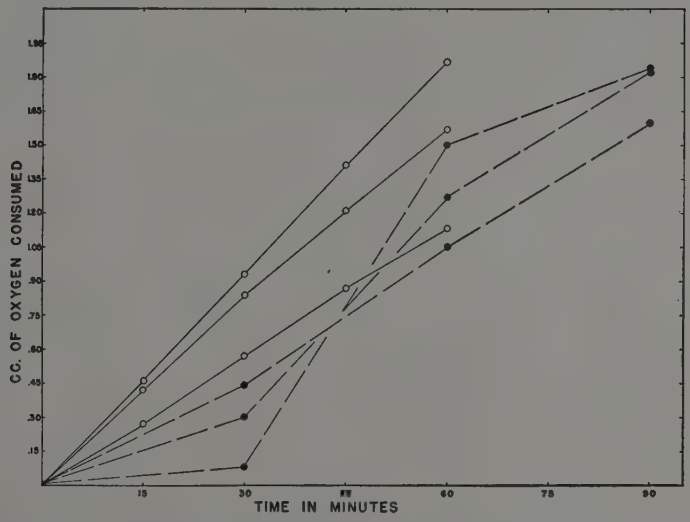

FIGURE 2. The rates in minutes (abscissa) of the oxygen consumption in cc of oxygen consumed/gm wet weight/hr, (ordinate) for the same goldfish as studied by the volumetric (O) and by the Winkler (●) techniques. Temperatures of 30.00 ± 0.01°C and 25.4°C, respectively.

directly related to the gaseous capacity of the compensatory chamber. There is placed inside of the index-marked capillary tube a colored fluid. The proximal (relative to the respiratory chamber) air-fluid interface of this column of fluid is made to coincide with the index mark at the time of obtaining each reading of the volume of oxygen consumed. This assures the maintenance of a constant gaseous pressure in the respiratory chamber. For compactness the extended third side-arm which carries the index fluid and compensatory flask encompasses the respiratory chamber, and is annealed to it in several places in order to gain rigidity.

Inserted into the ground-glass stopper are 3 small-bore outlets arising from a common vent. To each outlet is attached a syringe of any capacity dependent on the volume of oxygen to be measured during the course of the experiment. For studies on frogs and goldfish, syringes of 1 cc (100 division/cc) and 2 of either

5 or 10 cc capacity were most satisfactory. For more precise readings a microsyringe designed by Woodrow (1949) may be conceivably incorporated. These syringes are connected by pressure tubing. As the O_2 and CO_2 are removed by the organism and KOH solution, respectively, the difference in pressure between the respiratory and compensatory chambers forces movement of the index fluid towards the proximal reservior bulb. By appropriate movements of the pistons of the syringes, the proximal air-fluid interface is returned to the index mark and the volume of oxygen lost to the system is read directly.

The respirometers were immersed in a thermostatically controlled water-bath (30.00 ± 0.01° C), and were held in position by a rack which was originally adapted to fit into the shaft designed to hold Warburg manometers. The respirometers may be oscillated for varying distances and for varying frequencies characteristic of the shaking apparatus in question.

Although the volumeters have been used successfully on aquatic animals, goldfish and frogs (Calhoon and Angerer, 1949, 1950a, 1950b, 1951; Murray and Angerer, 1950), there is evidence that they may be adapted to small terrestrial animals providing that they are not cramped in the respiratory chamber. Studies were made upon the effect of shaking the apparatus at various frequencies. It was found that when the volumeters were not shaken they gave identical rates for oxygen consumption as when they were shaken 40 oscillations/minute. However, the values obtained with 40 oscillations/minute were sometimes variable. Further-

TABLE 1

Comparison of the respirometric and the Winkler methods

Methods	No. of Fish	°C. Temp.	Mean M.M.	Std. Dev.	Std. Error
Winkler	18	25.40	0.211	0.070	0.016
Respirometer	18	30.00*	0.282*	0.083	0.019

*The difference in mean metabolic rate (M.M.) is due to the difference in temperature, assuming a Q_{10} value of 2.7.

more, shaking at 80 oscillations/minute caused a three-fold increase in oxygen consumption over that obtained without shaking. This was due to the high oscillatory rate stimulating the animal to excessive movements and thus causing an increase in oxygen consumption. That the rate of oxygen consumption without shaking is indentical to that obtained with the Winkler technique is probably due to the movements of the animal being sufficient to mechanically mix the contained gas. Therefore, the respirometers were not shaken during the course of these experiments.

To compare the accuracy of the volumetric to the Winkler technique, oxygen consumption determinations were made by both methods on a group of 18 goldfish, *Carassius auratus*. All fish, weighing between 5 and 10 grams, were starved 12 to 18 hours prior to use in order to render them into, as near as possible, a post-absorptive state. The results are presented in Table 1 as cc of O_2 consumed/gm wet weight/hr. The mean value for oxygen consumption is substantially higher for the volumetric than for the Winkler technique (0.282 ± 0.019 and 0.211 ± 0.016, respectively). However, when correction is made on the basis of their Q_{10} values for the difference in temperature (30.00 ± 0.01° C and 25.4° C, respectively) at which the two sets of data were obtained, it is found that the means of the two sets of data are identical. Despite the difference in temperature at which the two techniques were run, the standard error (S.E., table 1) of the mean values for oxygen consumption is almost the same (± 0.003) in both cases.

SUMMARY

A direct reading volumeter, requiring no previous calibration has been devised for study of the oxygen consumption of small aquatic and amphibious animals. It is conceivably possible to extend its use to small terrestrial animals. A true mean value of 0.282 ± 0.019 cc O_2 consumed/gm weight/hr, at 30.00 ± 0.01° C was obtained for the common goldfish, *Carassius auratus*, by the volumetric respirometer. This value compares favorably with a true mean value of 0.211 ± 0.016 for the same fish at 25.4° C using the Winkler technique. The volunteers, therefore, show degrees of accuracy similar to the Winkler technique. An advantage in favor of the volumetric over the Winkler technique is found in the greater linearity of the points in the graph on plotting the cc of oxygen consumed as a function of time (fig. 2). Finally the volumetric respirometer reduces the laborious and time-consuming manipulations inherent in the Winkler technique.

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A Field Guide to the Mammals. *W. H. Burt and R. P. Grossenheider.* Houghton Mifflin Company. Boston. 1952. xxi+200 pp. $3.75.

This is the first functional field guide for the mammals of North America to be prepared for the amateur naturalist. Descriptions of species are brief and concise. In addition, a list of similar species, with noted differences, is included for each species listed and serves as an aid in separating confusing forms with the one under consideration. Several other important features also included are (1) a personal check-list of mammals, (2) distribution maps, (3) important field marks, (4) dental formulae, (5) photographs of 91 land mammal skulls, and (6) a large number of "tracks" which aid in recognizing the presence of many mammals in an area.

No student of wildlife and vertebrate zoology will want to be without this handy, pocket-size, field guide which is a welcome addition to our meager list of books dealing with our mammals. Since it is not encumbered by burdensome "keys," this book can be used by both layman and student alike. It is recommended for college courses in vertebrate zoology, ecology, and wildlife management as a standard field reference.

FRED H. GLENNY.

ANNUAL REPORT OF THE OHIO ACADEMY OF SCIENCE
1953

Organized 1891 Incorporated 1892
Affiliated with the American Association for the Advancement of Science

OFFICERS AND COMMITTEES FOR 1953–1954

President
R. A. HEFNER

Vice-Presidents

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B. *Plant Sciences:* ELTON PADDOCK
C. *Geology:* H. F. DONNER
D. *Medical Sciences:* H. G. SCHLUMBERGER
E. *Psychology:*
F. *Physics and Astronomy:* W. H. SHAFFER
G. *Geography:* MILDRED DANKLEFSEN
H. *Chemistry:* D. R. CLIPPINGER
I. *Mathematics:* L. L. LOWENSTEIN
J. *Science Education:* C. E. HOEL
K. *Anthropology and Sociology:* A. C. MAHR
L. *Conservation:* C. S. JOHNSON

Secretary
RUSH ELLIOTT

Treasurer
R. M. GEIST

Historian
W. H. ALEXANDER

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Elective: G. W. BLAYDES AND R. A. POPHAM

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B. *Plant Sciences:* A. H. BLICKLE
C. *Geology:* J. M. SCHOPF
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E. *Psychology:*
F. *Physics and Astronomy:* L. R. WYLIE
G. *Geography:* J. T. MADDOX
H. *Chemistry:* W. F. KIEFFER
I. *Mathematics:*
J. *Science Education:* VIOLET R. STRAHLER
K. *Anthropology and Sociology:* CLARENCE WARD
L. *Conservation:* E. L. WICKLIFF

Nominating
VICE-PRESIDENTS OF 1952–1953, R. P. GOLDTHWAIT, Chairman

Program
VICE-PRESIDENTS AND SECRETARY

Election of Fellows
VICE-PRESIDENTS AND SECRETARY

Library
ACADEMY LIBRARIAN, MORTON COBURN, Chairman
W. C. BEAVER.....Term expires 1955
A. W. LINDSEY.....Term expires 1957

Publications
SECRETARY, Chairman
W. C. BEAVER.....Term expires 1955
A. W. LINDSEY.....Term expires 1957

Resolutions
G. B. BARBOUR, Chairman,
Term expires 1954
W. A. MANUEL.....Term expires 1955
J. W. GEBHART.....Term expires 1956

Necrology
A. E. WALLER.....Term expires 1954
J. H. MELVIN.....Term expires 1955
H. H. M. BOWMAN, Chairman
Term expires 1956

Trustees of Research Fund
K. G. A. BUSCH, Chairman. Term expires 1954
E. S. THOMAS.....Term expires 1955
G. W. BLAYDES.....Term expires 1956

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1. On the Joint Administrative Board of the Ohio Journal of Science:
   W. C. Beaver.....Term expires 1955
   A. W. Lindsey.....Term expires 1957
2. On the Council of the A.A.A.S.: J. F. Stanfield

The Council for 1953–1954

W. C. Beaver	R. M. Geist	Elton Paddock
G. W. Blaydes	R. A. Hefner	A. H. Peterson
A. H. Blickle	C. E. Hoel	R. A. Popham
R. H. Bõhning	C. S. Johnson	H. G. Schlumberger
K. G. A. Busch	W. F. Kieffer	J. M. Schopf
D. R. Clippinger	F. H. Krecker	W. H. Shaffer
Morton Coburn	A. W. Lindsey	W. H. Shideler
Mildred Danklefsen	L. L. Lowenstein	Violet R. Strahler
H. F. Donner	J. T. Maddox	Clarence Ward
Rush Elliott	A. C. Mahr	E. L. Wickliff
E. H. Ellison	J. A. Miller	J. N. Wolfe
		L. R. Wylie

REPORT OF THE SIXTY-SECOND ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The sixty-second annual meeting was held on the Ohio State University campus on April 23, 24 and 25. Attendance and size of program presented were the largest in the history of the Academy. The fifth State Science Day of the Junior Academy of Science was the largest and most successful in the history of that group also, 233 exhibits presented by 246 Junior Academy members which had won superior rating in the District Science Days being in competition. Fifteen Junior Academy members were declared eligible for Ohio Academy of Science scholarships.

Programs were presented by all sections of the Academy and meeting in joint session with Academy sections were the Ohio Psychological Association, The Ohio Section of the American Physical Society, The Ohio Folklore Society and The Ohio Wildlife Management Association.

Excellent commercial exhibits were made by a large number of companies.

The annual banquet and business meeting were held in the East Ballroom of the Ohio Union on Friday evening at 6:45 P. M. Dr. A. E. Waller served as a most excellent toastmaster, greetings were extended from the Ohio State University by Vice-President B. L. Stradley, and the response for the Academy by Dr. W. H. Shideler. The presidential address by Dr. G. W. Blaydes was titled, "The Romance of Domesticated Plants."

The annual report of the Secretary which summarized the past year's activities included a report on membership, there having been 183 members, 10 Corporation and one Institution member added during the year. The present membership includes 1,341 members, 23 Corporation members, and 22 Institution members.

The following persons were announced as newly elected Fellows of the Academy:

William Adams, Jr.	S. O. Hoerr	G. W. Prescott
C. S. Bacon	T. D. Howe	A. E. Prince
C. H. Bowen	J. J. Jacoby	L. S. Putnam
G. W. Burns	A. G. James	C. R. Reese
C. A. Clendenning	E. V. Jotter	Irving Rothchild
T. J. Cobbe	K. L. Kelley	L. L. Shetler
Jean M. Cummings	T. C. Kennard	R. S. Sigafoos
W. E. Dunham	Dorothy J. Knull	H. V. Truman
E. H. Dustman	A. W. Marion	E. G. Voss
W. S. Emerson	Mildred F. Marple	A. M. Wallace
R. R. Finlay	C. B. Moke	C. R. Weaver
F. W. Fisk	J. L. Morton	W. E. Wilson
Walter Frye	W. G. Myers	Claude-Starr Wright
Otto Glasser	C. M. Palmer	H. C. Yingling, Jr.
L. L. Harrold	H. J. Pincus	P. E. Zimpfer
C. E. Hoel	J. B. Polivka	R. M. Zollinger

The membership approved an amendment to provide for a Director of Public Relations who is also to be a member of the Council.

Dr. F. H. Krecker, Executive Secretary of the Junior Academy, announced that awards to outstanding high school teachers were presented to Forrest Buchanan, Amsterdam; Helen

Deeter, Greenville; Charles E. Hoel, Bexley; R. J. Lockhart, Brecksville; Irwin Slesnick, Archbold; and John W. Wargo, Manchester Rural, Reinersville.

The Ohio Journal of Science Award for Excellence in Research was presented to Dr. Elizabeth W. Smith of Kent State University by Dr. Earl Green, Editor of the Ohio Journal of Science.

The report of the Necrology Committee was presented by Dr. H. H. M. Bowman, of the Nominating Committee by Dr. A. N. Solberg, and of the Resolutions Committee by Dr. A. W. Lindsey.

Respectfully submitted,

RUSH ELLIOTT, *Secretary.*

REPORT OF THE EXECUTIVE COMMITTEE AND COUNCIL

The Executive Committee met on December 5, 1952, and again on April 23, 1953, and the Council on December 6, 1952, and again on April 23, 1953.

An amendment to provide for a Director of Public Relations was authorized and passed.

A progress report on the work accomplished by the special committee on "Ohio Flora" was presented. To date a mimeographed report covering 10,000 Woody Plants has been issued and a study of Pteridophytes in Ohio is now in progress.

The Council approved the recommendation of the Executive Committee that in order to continue a close working relationship between the Academy and the Junior Academy, that the Executive Committee be empowered to appoint the District College Representatives of the Junior Academy Council and the Executive Secretary for the Junior Academy, the Council members to serve for a three-year term and the Secretary for a five-year term, the latter being subject to annual review by the Executive Committee of the Academy.

The Executive Committee recommended and the Council approved the following requirements for companies presenting commercial exhibits at the Annual Meeting: 1. Holding corporation membership; or 2. Payment of $25.00 fee to the Treasurer of the Academy; or 3. Running a minimum of a half page advertisement in at least one issue of the Ohio Journal of Science during the year, or the minimum equivalent of this in advertising cost.

The 1954 Annual Meeting is to be held at Ohio University on April 15, 16 and 17 as the first major event by a visiting group of the sesquicentennial program of the University; the 1955 meeting at Ohio Wesleyan University and the 1956 meeting at Bowling Green State University.

Respectfully submitted,

RUSH ELLIOTT, *Secretary.*

REPORT OF THE TREASURER

CURRENT EXPENSE FUND

Fiscal Year 1952

RECEIPTS:	
Bank Balance, January 1, 1952	$1,121.28
Membership dues	4,447.00
Sale of Publications	6.37
Interest, U. S. Bonds	47.50
	$5,622.15
EXPENDITURES:	
Subscriptions and Engraving, Ohio Journal of Science	$2,325.18
Printing Annual Report	299.32
Printing News Letters, Junior Academy	178.00
Programs for Annual Meeting	175.75
Postage, office supplies, bank charges and other administrative expenses	821.98
Bank Balance, December 31, 1952	1,821.92
	$5,622.15

RESEARCH FUND

Fiscal Year 1952

RECEIPTS:	
Bank Balance, January 1, 1952	$ 291.28
Interest, U. S. Bonds	7.50
Interest, Fort Hayes Hotel Bonds	52.00
Dividends, Banc-Ohio Stock	27.50
Grant, A. A. A. S.	248.00
Gift, Dr. Herbert Osborn	100.00
	$ 726.28

EXPENDITURES:

Grant, Janice C. Beatley	$ 60.00
Grant, Ohio Flora Committee	188.00
Grant, William Adams, Jr.	100.00
Grant, Robert M. Crowell	65.00
Grant, Louis M. Thomson, Jr.	80.00
Bank Charges	3.07
Bank Balance, December 31, 1952	230.21
	$ 726.28

REPORT OF THE TRUSTEES OF THE RESEARCH FUND

To the Ohio Academy of Science:

The Trustees of the Research Fund present the following statement covering the calendar year 1952, and extended to show the status of the fund as of 21 April, 1953.

INCOME:

Interest on Securities—		
U. S. Savings Bonds	$ 7.50	
Ft. Hayes Hotel Bonds	52.00	
Banc-Ohio Stock	27.50	
Grant from A. A. A. S.	248.00	
Gift per Dr. Herbert Osborn	100.00	
Total Income		$435.00

EXPENSES:

*Grant on Vegetation (Janice C. Beatley)	$ 60.00	
*Grant to Ohio Flora Committee (Glenn W. Blaydes)	188.00	
*Grant on Fern Study (Wm. Adams, Jr.)	100.00	
Grant, Robert M. Crowell	65.00	
Grant to Louis M. Thomson (reconstruction of giraffe skeletal material)	80.00	
Bank Charges	3.07	
Total Expenses	$496.07	
Excess Expense over Income		61.07
		$496.07

YEAR 1952:

Balance 1 January, 1952	$291.28
Less Excess Expense Over Income	61.07
Balance 31 December, 1952	$230.21

PERIOD 1 JANUARY TO 21 APRIL, 1953:

Balance 1, January, 1953	$230.21
Deposit, 2 February	12.50
	$242.71
Less Grant to Cecil Riser	50.00
Total Balance	$192.71
Cash Deposit on Hand	7.50
†Balance on Deposit	$200.21

*The starred grants were approved before the report presented at the Annual Meeting, April, 1952.

†This balance does not include a credit of $26 from interest received but not yet banked, nor to a grant due from A.A.A.S. for 1953; there is also a small deduction due for a bank charge. These items will appear in the 1953 report.

E. S. THOMAS,
K. G. A. BUSCH,
G. B. BARBOUR, *Chairman.*

REPORT OF THE LIBRARIAN

The librarian is pleased to inform the Academy that its official journal is used in four hundred and seventy-one exchanges. Seventy percent of these exchanges are with public and private institutions in fifty-seven foreign countries. Thirty percent of these exchanges are with domestic institutions in forty-three states.

EXCHANGE AGREEMENTS CONCLUDED BETWEEN THE O. A. S. AND DOMESTIC AND FOREIGN INSTITUTIONS
1951 – APRIL, 1953

	1951	January, 1952, to April, 1953	Percent increase over 1951
Total number of exchanges	400	471	17.75
Domestic exchanges	120	134	11.66
Foreign exchanges	280	337	21.35

NUMBER OF INDIVIDUAL TITLES RECEIVED IN EXCHANGE FOR THE OHIO JOURNAL OF SCIENCE, SEPTEMBER, 1951, TO DATE

1953	1952	1951
9	102	47

The largest number of foreign exchanges are with the following countries:

Argentina	16
Australia	16
Brazil	20
Canada	19
England	15
France	13
Japan	17
Spain	16
U. S. S. R.	20

Sales of the Academy's publications for the period January, 1952, through April, 1953, amounted to twenty-seven dollars and thirty-seven cents ($27.37). One dollar and thirty-three cents was withheld for the purchase of tax stamps; the remainder of the money was turned over to the Treasurer of the Academy.

Respectfully submitted,

MARTIN COBURN, *Librarian.*

REPORT OF THE JOINT ADMINISTRATIVE BOARD OF THE OHIO JOURNAL OF SCIENCE

The annual meeting of the Joint Administrative Board of The Ohio Journal of Science was held at Columbus, Ohio, April 8, 1953. The meeting was called to order by Board Chairman Dr. Spieker. Present were Drs. Spieker and Meyer, representing the Ohio State University, Drs. Tidd and Beaver, representing the Ohio Academy of Science, and Drs. Green, Popham, Böhning and Fisk of the Ohio Journal staff.

Dr. Spieker was elected Chairman of the Board for the year 1953–54. Minutes of the last meeting were approved as read.

The report of the Business Manager was approved as read. This report, which is attached to these minutes, was mainly in the form of a financial statement for Vol. 52.

The report of the Editor was approved as read. A copy of this report is appended to these minutes.

The selection by the Editor of Dr. Frank W. Fisk as Book Review Editor and Associate Editor was approved by the Board. Dr. Fisk has been serving in this capacity since July 1, 1952.

Dr. Green announced that an awardee had been chosen by the judges to receive the $150 prize for the outstanding paper submitted in the field of zoology according to the 1952–53 contest rules. The award will be made at the annual banquet.

Dr. Green announced that he has on hand sufficient manuscripts to fill issues of the Journal up to the March, 1954, number. The symposium on solar energy will probably be published in the September issue.

Dr. Fisk presented the report of the Book Review Editor and stressed the fact that there is a serious problem in the matter of finding sufficient space in the Journal to publish the very large backlog of book reviews presently on hand. Ways and means of speeding the publishing of these book reviews were discussed.

Dr. Popham submitted his resignation as Business Manager, stating that he had served in this capacity for four years. Following a discussion Dr. Popham agreed to serve as Business Manager until a suitable person could be selected to assume the duties of the office. Dr. Popham was nominated and elected Business Manager for Vol. 53.

Dr. Böhning presented an oral report of the Advertising Manager in which he stressed the fact that it is increasingly difficult to secure advertising for the Journal and that he anticipates that the amount of advertising secured will not appreciably increase due principally to the fact that advertisers consider the Journal a regional one. Due to the fact that the most strenuous efforts of the Advertising Manager have not yielded an increasing amount of advertising, he suggested that the office of Advertising Manager be abolished, and that the duties be assumed by the Business Manager. The Board decided to eliminate the office of Advertising Manager and to ask the incoming Business Manager to assume these duties.

Due to the fact that Dr. Green is to be on a two years leave of absence from the Ohio State University commencing about September 1st, he offered his resignation to the Board. Dr. Green's resignation was accepted by the Board with regret. Dr. R. H. Böhning was elected Editor to succeed Dr. Green. The date of the transfer of duties of Editor is to be mutually agreed upon by Dr. Böhning and Dr. Green.

At the insistence of the chairman, the Board extended to Dr. Green its expression of warm appreciation for his efficient stewardship of the office of Editor.

Dr. Spieker was instructed to appoint a committee to audit the books of the Business Manager for Vol 52.

It was decided by the Board to continue to offer for another year the Ohio Journal of Science Award for Excellence in Research. The field represented by the Section of Geology of the Academy was chosen as the one in which to make the award in 1954.

The Business Manager was instructed to charge non-authors seeking reprints of papers published in the Journal 150% of the cost of the reprints.

There being no further business the board adjourned.

Respectfully submitted,

RICHARD A. POPHAM,
Secretary of the Board.

THE OHIO JOURNAL OF SCIENCE

VOLUME 52, FISCAL YEAR 1952

RECEIPTS

Bank balance January 1, 1952	$1,370.64
Ohio State University—Paid for subscriptions	2,000.00
Ohio Academy of Science—Paid for subscriptions	2,135.00
Non-members—Paid for subscriptions	386.00
Sale of separate numbers, volumes and reprints	222.30
Ohio Academy of Science—Paid for one-half cost of plates	231.14
Ohio Academy of Science—Paid for Annual Report	103.32
Miscellaneous	17.50
Advertisements	737.52
	$7,203.42

EXPENDITURES

Spahr and Glenn Company—printing Journal	$4,544.00
Bucher Engraving—Plates	585.20
Postage and Express	214.57
Secretary and labor	48.50
Office supplies and bank charges	94.64
Advertising the Ohio Journal of Science	150.00
Bank balance, December 31, 1952	1,566.51
	$7,203.42

THE OHIO JOURNAL OF SCIENCE

Report of the Editor of Volume 52, 1952, to the Joint Administrative Board

Volume 52 of The Ohio Journal of Science contained 368 pages of text and 4 pages of index, not including 24 pages of cover. The text pages were devoted to 59 articles in eight fields of science (as represented by sections of the Ohio Academy of Science) to 59 book notices, and to various announcements, and advertisements. Among the articles were two symposia, one on "Physical methods in qualitative and quantitative chemical analysis," and one on "The Undergraduate Physics Curriculum." Also there was one collection of articles on the Orleton Farms Mastadon.

Manuscripts have been submitted and accepted to fill the entire of volume 53.

The General Index for the years 1900 to 1950 of The Ohio Naturalist and The Ohio Journal of Science, prepared by Ethel Melsheimer Miller, has been published.

Respectfully submitted,

Earl L. Green, *Editor.*

NECROLOGY REPORT FOR 1952-1953

It is the sad duty of the Necrology Committee to report the passing of 15 members of the Academy of Science during the period between April 1952 and April 1953. The deceased members are herewith listed with a brief biographic sketch of each:

Vernon S. Culp

Mr. Vernon S. Culp, Science teacher in West High School, Akron for 36 years and member of the Science Education Section since 1930.

Mr. Culp was born in Nappanee, Indiana on Sept. 6, 1889. After attendance in local public schools he entered Goshen College at Goshen, Indiana and secured the Bachelor of Arts degree in 1915. He later attended the University of Indiana and was granted the Master of Arts degree. He did additional graduate work at Ohio State University, Akron University and Western Reserve University. In 1916 he began teaching in West High School, Akron in chemistry, physics, German and photography. During World War II Mr. Culp served as physics teacher to the Air Forces stationed at Kent State University. Since 1929 he has been Boy's Counselor at West High School.

He was a member of the National and State Education Associations and the American Chemical Society, the A.S.A.S., the Ohio Academy of Science, the Cleveland Regional Council of Science Teachers and the State and National Science Teacher's Association. He was a member of the Torch Club. For many years Mr. Culp served as treasurer of N. E. Ohio Chemistry Teacher Association. He was married in 1914 to Sylvia E. Miller. To this union were born 2 children, Eugene E. Culp, and Mrs. Julia Marsten. He died on Dec. 15, 1952, of coronary thrombosis and was buried in Rose Hill Cemetery, Akron.

Mrs. Mildred Vickroy Davis

Mrs. Mildred Vickroy Davis, Science teacher in the High Schools of Connelsville and Glouster, Ohio and a member of the Science Education Section.

She was born on Nov. 3, 1897 in Union Township, Morgan County, Ohio. After preparation in the public schools matriculated in Ohio University from which she received the Bachelor of Arts degree. She also later did graduate work at Ohio State University. In 1934 she was married to Oscar Roy Davis by whom she had one child, Ella Mae Davis. She died on May 29, 1952 of a cerebral hemorrhage and was buried in Maplewood Cemetery, Glouster, Ohio.

Ernest Sanford Dix

Professor Ernest Sanford Dix, geographer and member of the Geography Section of the Academy.

Mr. Dix was born in Starrucca, Penna. on June 3, 1919. After a public school education he entered Penn. State College and was graduated in 1941, with the Bachelor of Science degree. Then he was awarded a Garver Fellowship at Clark University and secured the M.A. degree in 1948. In succeeding years he was visiting lecturer at the University of Kansas City, and in 1949 became assistant Professor of Geography in Miami University at Oxford, Ohio. In 1952 he secured a leave of absence to become Visiting Lecturer on Geography in the University of Malaya at Singapore where his untimely demise occurred.

In 1943 Prof. Dix married Louise Carter and to them were born two sons, Terry Elliot Dix born in 1947 and Theodore Howard Dix born 1949. He was a member of the Association of American Geographers, the National Council of Geography Teachers, Phi Eta Sigma, Gamma Sigma Delta and Phi Kappa Phi fraternities. Prof. Dix died on April 5, 1952 of polio-encephalitis in Singapore and was buried in that city.

Mr. Louis A. Elsesser

Mr. Louis A. Elsesser, teacher of Mathematics and Science, and a member of the Conservation Section.

Mr. Elsesser was born in Tiffin, Ohio on Dec. 29, 1894. After graduation from the Tiffin High School he entered Heidelberg College in Tiffin and received the Bachelor's degree about 1918 and later a Master's degree from Ohio State University. In 1918 he became principal of the high school at Litchfield, Ohio and the next year Superintendent of its schools. Within the three years he served as co-normal director for West Union and Carrolton and in September 1923 until his death in 1952 he was the teacher of mathematics and science in the Myron T. Herrick Junior High School in Cleveland. In this work he was highly successful and established the first School Conservation Museum in Cleveland. From this conservation programs have developed in many high schools in Ohio. He also served 18 years on the Greater Cleveland Boy Scouts Council and as District Commissioner, a Sea Scout Master, Merit Badge Counselor and an Eagle Scout, which qualified him for 39 merit badges. He for years rendered great service in the Boy Scouts of America.

In 1940 he married Mrs. Thelma E. Storey. No issue accrued from this union. On March 29, 1952 Mr. Elsesser suffered a fatal cerebral hemorrhage and was buried in Calvary Cemetery, Cleveland, Ohio.

Ray C. Friesner

Dr. Ray C. Friesner, Professor of Botany at Butler University, Indianapolis and member of the Plant Science Section.

Dr. Friesner was born at Bremen, Ohio on Feb. 8, 1894 and after graduation from the Bremen high school matriculated in Ohio Wesleyan University and was graduated with the Bachelor of Arts degree in 1916. He later went to the University of Michigan for graduate study and received the Ph.D. degree in 1919. The same year he took a position as instructor at Butler University and in 1920 a separate Department of Botany was set up and of which he became the head, which position he held until his death. He sponsored the celebrated Butler Botanical Studies comprising the researches of his students and candidates for Master's degrees. In 1944 the alumni of the Department celebrated its Silver Anniversary with a special memorial issue of the Studies.

From 1944 to 1947 Dr. Friesner was Director of the Graduate Division. In 1947 he became Dean of the College of Arts, while continuing as Head of the Botany Department. He received many honors, including election to Phi Betâ Kappa, Phi Kappa, Sigma Xi. He was a member of the A.A.A.S. the Botanical Society of America, as well as the State Academies of Michigan, Ohio, Indiana and Pennsylvania, Illinois and Washington. He also belonged to the Eugenics Society and the American Assn. of University Professors. He published numerous papers on the Indiana flora and a memorial issue of his Key to Indiana Plants is being published.

In 1925 Dr. Friesner married Miss Gladys Miller. In 1948 he was awarded the Holcomb Award for meritorius service to Butler University, and in 1951 he was given an honorary Doctor of Science degree from his alma mater Ohio Wesleyan University. He died of coronary occlusion on Dec. 1, 1952, and was buried in a rural cemetery near his native Bremen, Ohio.

Marion Dwight Harbaugh

Mr. Marion Dwight Harbaugh, President of the Lake Superior Iron Ore Association and member of the Geology Section.

Mr. Harbaugh was born in Kansas City, Mo. on May 18, 1892. After his elementary education Mr. Harbaugh entered the University of Wisconsin and received the B.Sc. degree in mining engineering in 1923. In 1925 from the same institution he obtained a Master of Science degree in geology. From 1910 to 1919 he was engaged in the practice of civil engineering making surveys for railways, highways, and municipal projects in Missouri and Arkansas. While doing graduate work at Wisconsin he was employed in the Department of Geology as an assistant and also on research work for the State Geological Survey. From 1923 to 1924 he was employed as geologist for the American Aluminum Company in fluorspar explorations in Kentucky and Illinois and also on hydro-electric projects in North Carolina. In 1924 he returned to Wisconsin University as Instructor in Engineering Geology while employed also on various mining and petroleum surveys in the field. From 1927 to 1929 Mr. Harbaugh was engaged in professional work as an economic geologist in the United States, Canada, Newfoundland and Mexico.

In 1929 he became the executive secretary for the Tri State Zinc and Lead Ore Producers Assn. with headquarters at Miami, Okla. engaged with administrators work and technical investigations, publications etc. until 1936. In 1937 he moved to Cleveland Ohio to become the Vice President of the Lake Superior Iron Ore Assn. He served as an executive officer and technical advisor for the Company and was editor of the volume on *Lake Superior Iron Ores* published in 1938 and a monograph, *Iron Ore*, published in 1948 by the Mining Congress Journal. In 1951 he was elected president of the Lake Superior Iron Ore Association which office he held until his death.

In 1924 Mr. Harbaugh married Marjorie B. Warvelle and to them were born John Warvelle Harbaugh, Daniel Warvelle Harbaugh, Philip Warvelle Harbaugh, Marjorie Bangs Harbaugh and Sylvia Prettyman Harbaugh. He died on March 19, 1952 of coronary thrombosis and was buried at Hudson, Ohio.

Harold Charles Hulme

Mr. Harold Charles Hulme, Science teacher in Warren G. Harding Senior High School, Marion, Ohio and member of the Science Education Section.

Mr. Hulme was born at Leavittsburg, Ohio on Dec. 19, 1905. In 1932 he became the teacher of Natural Science in the Warren G. Harding Senior High School at Warren, Ohio but was especially active in the field of botany. His interest in travel was one of the impelling forces of his professional work and as a result of this he organized trips for his students to many distant parts of the United States, Canada, and Mexico—always with the purpose of fostering in them an interest in the natural sciences. He was also devoted to music and dramatic art and was an inspirational power for the encouragement of cultural influences in the lives of his students. From the inception of the Ohio Academy of Science News Letter, the official organ of the Junior Academy, he was its indefatigible editor, and to whose memory the issue of November 1952 was dedicated.

Mr. Hulme never married and at the untimely age of 46 was stricken with carcinoma due to which his death occurred on Sept. 13, 1952. He was buried in Crown Hill Cemetery, Vienna, Ohio.

Harvey Evert Huber

Professor Harvey Evert Huber. Head of the Department of Biology at Ohio Northern University and member of the Zoology Section since 1912.

Professor Huber was born at Bluffton, Ohio on March 19, 1884 and after a public school education entered Ohio Northern University and was graduated in 1908 with the Bachelor of Arts degree. The following year he received the Bachelor of Science degree from the same institution and in 1912 he received the Master of Arts degree from Yale University. He also pursued some graduate study at the University of Wisconsin, but since 1913 had been on the Faculty at Ohio Northern and for many years until 1952 served as Dean of its College of Arts and Science.

In 1913 he married Miss Ida May Cotner. To this union one son, Max Marvin Huber, now of South Bend, Indiana, was born. Dean Huber was a member of numerous honorary organizations including Alpha Phi Gamma, Sigma Phi Epsilon and Kappa Kappa Psi. He was a member of the A. A. A. S. and a Fellow of the Ohio Academy of Science. He was active in Masonry and had attained the 32° of the Scottish Rite. He was also a Past Patron of the the Order of the Eastern Star.

On April 21, 1953 Dean Huber died suddenly of coronary thrombosis leaving his wife and one son surviving. The interment was in the Ada Cemetery at Ada, Ohio.

Clarence Hamilton Kennedy

Dr. Clarence Hamilton Kennedy, Professor of Entomology, Ohio State University and Fellow of the Zoology Section.

Dr. Kennedy was born in Rockport, Indiana on June 25, 1879. He recieved the A. B. degree from Indiana University in 1902 and the M.A. degree in 1903. In 1914 he obtained an M. A. degree from Stanford University and the degree of Doctor of Philosophy from Cornell in 1919.

In 1902 and 1903 he served as an assistant at Indiana University and then accepted a position on the scientific staff of the U. S. Bureau of Fisheries. In 1908 he toured Oregon and Texas as a collector for the herbarium of Mount Holyoke College. From 1913 to 1915 he was employed as a scientific artist. From 1915 to 1917 he was an instructor in biology and limnology at Cornell, and from 1918 to 1918 at North Carolina University. In 1919 he came to Ohio State University as Instructor in Entomology. He became an assistant Professor of the subject in 1921 and associate in 1930 and Professor in 1933 which chair he occupied to his death. He was also in charge of entomolgy at the Franz Stone Laboratory from 1920 to 1938. He was summer instructor at Biological Stations in Indiana and Cornell.

In 1927 Dr. Kennedy married Miss June Findley. To this union two children were born, Bruce Hamilton Kennedy and Mary Janet Kennedy. Dr. Kennedy was honored by his alma mater with a honorary Doctor of Science in 1950. He was a member of the A. A. A. S. He was President of the American Entomological Society in 1935 and managing Editor of its Annals. He was a member of the Economic Entomologists, the Society of Naturalists, on the Editorial Board of the Amer. Ecological Society, Fellow of the Ohio Academy of Science and its Vice President for Zoology in 1926 and 1937. He was also a member of the Indiana Academy of Science a Fellow of the Entomologist Society of London and the Societé Entomologique of France. He was a specialist on the Odonata of the United States. Dr. Kennedy suffered a fatal cerebral hemorrhage on June 6, 1952 and was subsequently cremated.

Charles Herman Kuehnle

Mr. Charles Herman Kuehnle, Science Teacher in Canton and member of the Plant Science Section.

Mr. Kuehnle was born in Crawford County, Ohio on Oct. 16, 1891. He secured his early education in the public high school from which he entered Kent State University and secured the Bachelor of Science in Education in 1934 and the Master of Arts degree in 1939 from the same institution. His first position was that of science teacher in District 8 in Crawford County and a few years later became principal of the East Side High School in Bucyrus. During World War I he served his country as a Sergeant in the Army. After his return to civil life he accepted the position as biology teacher and Head of the Biology Department at Lincoln High School Canton, Ohio which he held until his death.

In 1917 Mr. Kuehnle had married Miss Elsie Sherer who preceded him in death. There were no children to this union. He had been elected to the Ohio Academy of Science in 1934 and was known to many members as a conscientious and inspiring teacher of biology.

He died of pneumonia on April 15, 1952 and was buried in Oakwood Cemetery at Bucyrus, Ohio.

Charles Ellison MacQuigg

Dean Charles Ellison MacQuigg, Dean of the College of Engineering at Ohio State University and Fellow of the Geology Section.

Dr. MacQuigg was born on Jan. 19, 1885 at Ironton, Ohio and after a public school education he matriculated in Ohio State University from which he was graduated with the degree of Mechanical Engineer in 1909.

In 1912 he married Miss Lillian Rodgers and to them were born three sons, Rodger Ellison MacQuigg, David Ellison MacQuigg and Charles Harrison MacQuigg. From 1909 to 1910 he was employed by the Santa Fe Railroad as a civil engineer, and from 1910 to 1912 in charge of testing for the Anaconda Copper Co. In 1912 he took the position as head of the Metallurgy Dept. at Penn State College where he remained until 1917. During 1917 to 1919 he served in the Army with the commission of Captain in the Ordinance Dept and later until his death as a Lt. Col. in the Officers Reserve Corps. From 1919 to 1937 he conducted research for the Carbide and Carbon Co. and from 1937 until his death he was Dean of the Engineering College of Ohio State University. He was also Director of the Ohio Engineering Experiment Station since 1937. He was a councillor of the Ohio State Research Foundation and a member of the Ohio Water Researches Board.

He was a Morehead Medalist of the Internat. Acct. Assn.; member of the Assn. Inst. of Mining and Metall. Engineers; of the Amer. Soc. Mech. Engineers; President in 1947–1948 of the Amer. Soc. for Engineering Ed; Fellow since 1947 of the Ohio Academy of Science; member of the Newcomen Soc. A. A. A. S. Amer. Soc. for Metals; Sigma Xi, Tau Beta Pi and contributor to numerous technical journals. On April 24, 1952 Dean MacQuigg suffered a fatal attack of a virus infection at his home in Columbus and was buried in Ironton, Ohio.

John B.McGrew

Mr. John B. McGrew, Attorney of Springfield, Ohio and member of the Physics Section.

Mr. McGrew was born on Oct. 6, 1870 in Springfield and lived there his entire life. After a public school education he entered Wittenberg College and was graduated with the Bachelor of Arts degree in 1891. He then attended the Law School of Columbia University New York and graduated with the Bachelor of Law degree in 1894 and was admitted to the Bar of New York in June 1894, but in October returned to Springfield was admitted to the Bar in Ohio. For the rest of his life he practiced law in Springfield and served as Prosecuting Attorney for Clark County from 1900 to 1906. In Feb. 1906 Mr. McGrew married Miss Elizabeth R. Little. There was no issue to this union. As an attorney he had a great variety of interest. He was a member of the Springfield Archeological Society, the A. A. A. S., The Clark County Historical Society, Amer. Museum of Nat. Hist.; The Young Men's Literary Club, Trustee of the Warder Public Library of Clark County, a warden of Christ Episcopal Church, Secretary and Trustee of the Ohio Masonic Home, Past Grand Commander of the Knights Templar of Ohio; Alpha Tau Omega fraternity, the Clark County Bar Assn.; the Ohio State Bar Assn. and the Amer. Bar Association. On August 21, 1952 Mr. McGrew suffered an automobile accident which caused his death on August 30, 1952. He was buried in Ferncliff Cemetery, Springfield.

Hugh Emerson Setterfield

Dr. Hugh Emerson Setterfield, Assoc. Professor of Anatomy at Ohio State University and member of the Medical Science Section.

Dr. Setterfield was born near Shelby, Ohio on May 12, 1900 and after attending local public schools he entered Wittenberg College and was graduated with its A. B. degree in 1923. In 1924 he secured the Master of Science degree at Ohio State University. He had started teaching zoology at Wittenberg College and was especially interested in anatomy on which he published numerous articles. After some teaching at Ohio State in 1924 he moved to North Dakota Agricultural College as Instructor in Zoology and from 1925 to 1927 he served as Instructor in Zoology at Ohio State University and from 1927 to 1929 as Instructor in Anatomy, from 1929 to 1937 as assistant Professor and from 1937 to his death was associate Professor of Anatomy at Ohio State.

Dr. Setterfield while at Ohio State pursued graduate study in Anatomy and was granted the Ph.D. degree in 1935. He belonged to numerous societies and since 1943 was national president of the Alpha Epsilon Delta national honorary premedical society. He was also a member of Kappa Phi Kappa, Gamma Alpha, Sigma Xi and Nu Sigma Nu medical fraternity. He was the associate editor of the Scalpel, organ of Alpha Epsilon Delta. He was a member of the Ohio Academy of Science since 1924 and a Fellow since 1935 and also a Fellow of the A. A. A. S.

In 1952 Dr. Setterfield married Mrs. Maria Voskamp. He was the father of these children, Halder Hugh Setterfield of Columbus and Suzanne Setterfield and Elizabeth Setterfield of Waterford, Conn. On March 16, 1953 Dr. Setterfield died of coronary thrombosis and was buried in Union Cemetery Columbus, Ohio.

Allyn Coats Swinnerton

Dr. Allyn Coats Swinnerton, Head Dept. of Geology at Antioch College and member of the Geology Section.

Dr. Swinnerton was born in New Berlin, New York, on September 1, 1897. After attending local public schools he entered Williams College and received the Bachelor of Arts degree in 1919. In 1920 he secured a Master of Science degree at Harvard and the Ph.D. degree in 1922. In the same year, 1922, he joined the Faculty of Antioch College and married Miss Matilda Saunders. There were no children born to this union. He served as head of the Geology Department at Antioch since 1922, but from 1932 to 1942 was also assistant to the President. His interest in all the earth sciences fitted him to teach physical and historical geology, economic geology, hydrology and mineralogy.

From 1924 to 1936 he was assistant geologist for the U. S. Geological Survey and in 1933 consulting geologist for the Tenn Valley Authority. He served with distinction in both World War I and II. In the latter as a Lt. Colonel in the Signal Corps. He was director of the Long Branch Signal Laboratory in New Jersey. He did important research in the development of artifical quartz crystals. He was awarded the Legion of Merit Medal in 1946 for conspicious service. He was Director of the Quartz Research at Antioch College for which he is internationally known. Dr. Swinnerton was a Fellow of the Amer. Geological Society, Fellow of the A.A.A.S. and Secy. of its Geology Section. He was a member of Sigma Xi, the Ohio Academy of Science, the Amer. Mineralogical Society, Amer. Geophysical Union, the Amer. Geographic Society and the Naturalists Speleological Society. On July 6, 1952 Dr. Swinnerton died of a celebral hemorrhage and was buried in Oneida, New York.

Karl Versteeg

Dr. Karl Versteeg, Professor of Geology at Wooster College and member of the Geology Section.

Dr. Versteeg was born on March 10, 1891 at Pella, Iowa. After graduation from the Pella High School he entered Central College in Pella and received the Bachelor of Science degree in chemistry in 1914 and served as an assistant in the Department and nevertheless graduated with Phi Beta Kappa. His first position after attaining his degree was Science teacher in Pella High School during 1914 and 1915. From 1915 to 1917 he was principal of the high school at Preston, Minn. as well as science teacher and athletic coach, next during 1917 and 1918 he held a similar position in the high school at Neenah, Wisconsin.

During World War I he served as Director of Athletics in Camp Dodge. After the war he secured a position as athletic coach at Du Pont High School in Louisville, Ky. During summers he enrolled in the University of Chicago and in 1926 he had married Miss Helena Martha Erdman, a former Red Cross nurse he met in the Army. From 1919–1920 he was instructor in geology in the University of Idaho, next he became head of the Geology Department of the Wisconsin School of Mines from 1920–1923 and from 1923–1926 he was Assistant Professor of Geology and Geography at Wooster College and from 1926 to his death was Professor and Head of the Department. He carried extra assignments in the summers as special lecturer in meterology and geography at Michigan College of Mines for the Army Air Force and organized the Civil Pilot training program at Wooster College 1940–41. In 1930 he received the Ph.D. degree in geology from Columbia University and in 1946 an honorary D.Sc. from his Alma mater in Iowa.

Dr. Versteeg served on many civic boards, etc. as the Conservation and Flood Control Committee of the Ohio Chamber of Commerce, member of the U. S. Chamber of Commerce, Vice-President of the Ohio Athletic conference 1947–49 and was a Fellow of the Ohio Academy of Science and Vice–President for the Geology Section in 1947. He was a member of Sigma Xi, Fellow of the Geological Society of America, Fellow of the A. A. A. S.; member of the Geophysical Union, New York Academy of Science, the A.A.U.P., the National Education Association, the Ohio Forestry Assn. and the Assoc. of American Geographers. On Oct. 10, 1952 Dr. Versteeg suffered a fatal apoplectic stroke and was buried at Pella, Iowa, survived by his wife.

A summary of this report shows that the average age of these 15 members was *61.06* years. A study of the causes of death shows that 5 deaths were due to cerebral hemorrhage, 5 to coro-

nary disease, one each to cancer, pneumonia, poliomyletis and virus infection and a traffic accident. Cerebral accidents have now competed with an equal number of cardiac deaths. The great mortality this year in the 5 deaths due to cerebral hemorrhage naturally is associated with the fairly high average age of *61.06* years. The sections in which these members were enrolled were Geology 4, Science Education 3, Plant Science 2, and Zoology 2 and Geography, Physics, Medicine and Conservation each one—the highest mortality being in the Geology Section.

Respectfully submitted,

H. H. M. Bowman, *Chairman.*
A. E. Waller,
J. H. Melvin
Necrology Committee.

REPORT OF COMMITTEE ON RESOLUTIONS

Be it Resolved, that the members of the Ohio Academy of Science express to the administration of the Ohio State University and to the members of the Local Committee on Arrangements their gratitude for the excellent facilities and gracious hospitality which have enabled us to enjoy a very successful sixty-second annual meeting.

Be it further Resolved, that the members of the Academy extend their gratitude to Dr. Herbert Osborn for his long service as Director of the Ohio Biological Survey which he is about to terminate in his ninety-seventh year.

Be it further Resolved, that the members of the Academy tender their appreciation to Dr. Earl Green for his able service as editor of the Ohio Journal of Science.

Be it further Resolved, that the members of the Academy express to Dr. Rush Elliott their appreciation for his very able and efficient service as Secretary during the past seven years, with the hope that it may long continue.

Respectfully submitted,

G. B. Barbour,
W. A. Manuel,
A. W. Lindsey, *Chairman.*

Principles of Petroleum Geology. *E. N. Tiratsoo.* McGraw-Hill Book Company, Inc., New York. 1952. xix+449 pp. $7.50.

This book, which is based on lectures given at the Royal School of Mines, London, is intended for both students and practitioners of petroleum geology. After a brief introduction, the author discusses the origin, migration, and accumulation of petroleum (67 pages); the world's oil fields (190 pages, of which 57 are devoted to fields in the United States); exploration, including geophysics (72 pages); exploitation of known fields, with a chapter on drilling muds (52 pages); and methods of correlation (29 pages). Format and typography are pleasing, and few printing errors appear.

As petroleum geology is a dynamic science that, in the author's own phrase, "has developed with increasing momentum," it seems incumbent on a writer on the subject (to say nothing of his publisher) to see that his work is as well abreast of recent developments as possible. Much evidence suggests that this book is at fault on this count. To take two random examples, the bibliography on migration of oil contains no reference later than 1939; and the oil-field map of the great West Texas basin is taken from a publication of 1938 and does not show oil fields that for years have been major producers. To rely extensively on the basic researches published in the 1930's is certainly permissible, but not to the exclusion of important works of more recent date.

This reviewer is unable to evaluate the author's grasp of the geology of foreign oil provinces, but several statements in regard to U. S. fields are inaccurate. The Salt Creek oil field of Wyoming is scarcely "on the eastward slope of the Big Horn Mountains" (page 223), as it lies at least 25 miles from the mountain front. The Central Basin Platform of West Texas was not "formed on a reef of Big Lime limestone" (page 200); on the contrary, the reef was formed on the uplift.

Such subjects as limestone reefs, facies changes, and unconformities do not receive separate treatment, but numerous examples of each are to be found in the many oil-field descriptions.

The author seems on his surest ground when discussing methods and techniques, as in the determination of porosity and permeability, the various geophysical methods, and the procedures in geologic mapping.

Robert L. Bates.

Soil Microbiology. *Selman A. Waksman.* John Wiley & Sons, Inc., New York, 1952. vii+356 pp. $6.00.

This newest book from the prolific pen of Dr. Waksman is similar to his previous volumes, Principles of Soil Microbiology and the Soil and the Microbe. As there are no currently available books on this subject, this new text should find immediate use in college Soil Microbiology courses.

The aims of this book are "to survey the nature and abundance of microorganisms in the soil, to review the important role that they play in soil processes, and, so far as possible, to show the relation between them and soil fertility." A general discussion of the soil microbiological population and interrelationships, the decomposition of plant and animal residues and formation of humus, the transformation of nitrogen and other plant nutrient elements in the soil, and the associative and antagonistic effects of soil microorganisms is presented in sixteen chapters.

Dr. Waksman, the 1952 recipient of the Nobel Prize for Medicine (discovery and use of Streptomycin) has written a readable and interesting textbook. There are sufficient subheadings and illustrations in the book to satisfy most instructors. A selected bibliography has been placed at the end of each chapter.

Historical coverage is good but little mention is made of recent and important findings on the stabilizing influence of clay minerals on soil organic matter and nitrogen, the effect of incorporated green manures on the destruction of soil humus, or the fractionation of soil humus using the newer techniques of chromatography, electrophoresis, spectroscopy and radioactive tracers.

Mechanisms of reactions (nitrification, nitrogen fixation, etc.) could have been discussed in metabolic terms of dehydrogenations, carrier systems and hydrations with appropriate enzyme systems specified rather than in terms of oxygen molecules utilized.

J. L. MORTENSEN AND W. P. MARTIN.

Quantum Theory of Matter. *J. C. Slater.* McGraw-Hill Book Company, Inc., New York. 1951. xiv+528 pp. $7.50.

This book sketches the quantum theory of matter with a minimum of mathematical detail. It should serve non-physicists as well as physicists and students with a fair knowledge of mathematics as an excellent introduction to that vast subject. The book presupposes a fair understanding of classical and statistical mechanics, electromagnetism, thermodynamics, and elementary atomic and molecular structure. The first seven chapters develop the fundamentals of quantum mechanics and culminate with a treatment of the central field model of atomic structure and the theory of multiplet structure of complex atoms (chapters 6 and 7 respectively). The remaining chapters deal with the main subject of the book and bear the titles: the Hydrogen Molecule, Interatomic and Intermolecular Forces; the Metallic State; the Mechanical, Chemical, and Thermal Properties of Matter; Electrical Conductivity; the Nature of Dielectrics; and finally, Magnetism. There are several appendices which elaborate to some extent the mathematical details omitted in the text. Copious well selected problems at the end of each chapter serve to give the student further training and to help him round out and fix the ideas developed. However, close reading of the text will be required of the student in order to handle these problems, and unless he has a fair degree of maturity he should not attempt this book without a teacher. **Quantum Theory of Matter** is a welcome addition at the intermediate level for college and university instruction and it is a pleasure to recommend it.

B. T. DARLING.

Problems of Life. *Ludwig von Bertalanffy.* John Wiley & Sons, Inc. New York. 1952. xi+216 pp. $4.00 (First American Edition).

This book is the English version of "Das Biologische Weltbild," first published in 1949, and is an exposition of Professor Bertalanffy's organismic conception and an evaluation of modern biological thought. The organismic conception is in contrast to both the mechanistic and vitalistic views. Based upon more recent advances in the natural sciences, it offers a much more acceptable approach to the explanation of life than either of the earlier views. The organism is treated as an integrated, functionally interdependent whole rather than as a sum of independently functioning parts. Gestalt psychology fits into the organismic conception so well that it might serve to illustrate the general approach to the organismic conception.

FRED H. GLENNY.